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CONTENTS.

EDITORIAL: PAGE.
Paragraphs 423

ILLUSTRATED ARTICLES:
The Institute Badge 424
Laboratory Notes—XL, by Lieut. F. Jarvis Patten 424
On the Origin of the Factor 4π in the Equation for the Magneto-Motive Force of a Coil, by A. E. Kennelly 426
The Westinghouse Electric and Manufacturing Company at the World's Fair 427
Westinghouse Engines at the World's Fair 432
The See-Sawing of Arc Lamps, by George Cutter 433
The First Three-Phase Transmission Plant in the United States 43
The Improved Laclede Battery 434
Non-Inductive Wattmeter for Direct Currents 434
Condensers for Electric Lighting Plants 434
An Arc Mast Arm 435
Improved Power Press 435

MISCELLANEOUS:
Defective Flywheels, by W. Stuart-Smith 424
Answer to "A Query," by Townsend Wolcott 424
Single-Phase vs. Two-Phase Systems, by Elias Ries and Gordon J. Scott 426
Economy of Incandescent Lamps 426
Digest of Current Technical Electrical Literature, compiled by Carl Hering 427
Two Interesting Displays at the World's Fair 433
The Cummings & Engelman Conduit 435
The Death of Anthony Reckenzaun 435

FINANCIAL 435
AFFAIRS OF THE COMPANIES 435
NEW INCORPORATIONS 436
SPECIAL CORRESPONDENCE: New York Notes, 436; New England Notes, 436; Western Notes, 433.
NEWS OF THE WEEK: Electric Light and Power, 436; The Electric Railway, 436; Miscellaneous Notes, 437.
TRADE AND INDUSTRIAL NOTES 437
BUSINESS NOTICES 437
OUR ILLUSTRATED PATENT RECORD 438

Low Frequency Currents. IN "Laboratory Notes" in another column Lieutenant Patten describes an ingenious method for obtaining low frequency alternating currents from direct currents. As pointed out, this method has an important application for medical uses. Not only can any desired frequency of current within the limits of the apparatus be obtained and exactly controlled, but by different dispositions of the plates in the liquid commutator the shape of the curve representing the current may be altered so as to vary the effect of the shock. The writer refers to the agreeable effect on the physical system of currents transformed by this method, due to the gradual manner in which the nervous strain is applied and relieved. Another interesting application is in the production of multiphase currents, although the low frequency to which the apparatus is limited renders any practical applications to power purposes problematical.

Defective Flywheels. THE article in another column by Mr. W. Stuart-Smith on the subject of defective flywheels is a timely one and calls attention to a point of the greatest importance. In the discussion of flywheel accidents it is almost invariably assumed that the cause is due to tangential strains, which involves the further assumption of an increased speed of the engine, and a defective governor is held up as the initial cause. As pointed out by Mr. Stuart-Smith, a sufficient cause for such accidents is a want of symmetry in a wheel with respect to a plane perpendicular to the shaft. This may follow from the construction of the wheel itself or from its being so mounted as not to run true. From the design of flywheels they are incapable of resisting any considerable lateral strain, and there is every reason to believe that many accidents ascribed, without sufficient evidence, to defective governors have been due to the cause referred to. In the construction of armatures these various points have been considered, and manufacturers of flywheels will do well to refer to the work of electrical authorities on this subject for data.

Magneto-Motive Force. IN another column Mr. Kennelly very clearly shows the origin of the factor 4π in the expression of the magneto-motive force of a coil. As pointed out, its presence is due to the definition of a unit magnetic pole, which, in turn, depends upon the definition of unit force. Dr. Heaviside proposes that the system of units be so changed that this constant may be replaced by unity, but it is improbable that the suggestion will be adopted, as the amelioration introduced in this respect would be accompanied by a confusion out of all proportion to the benefit conferred. Besides, it would be merely shifting the constant to other expressions, as it is inseparable from central forces. The proposition of Prof. Rosebrugh, made in these columns several months ago, to combine the constant with μ, the permeability, is also open to similar objections, and to the additional one that it would tend to conceal the principles concerned. The practical man uses the expression merely as a formula, and therefore it is almost a matter of indifference to him if the 4π is present or not, so that the matter is only of import to the mathematician, and with him it seems to be merely a question of convenience.

Economy of Incandescent Lamps. IN considering the question of economy of incandescent lamps it should be borne in mind that two principal factors enter. One of these is that the unit of light costs less as the incandescence of the filament is increased, and the other depends upon the falling off in the efficiency of the filament with use. If an expression could be found for the variation of the life of a filament with the incandescence at which it is used, it would be a simple matter, leaving aside the second factor, to decide in any case what lamp would be the most efficient. As it is, this determination can be approximately made without much difficuliy. Large users of lamps would find it to be to their interest to experiment with lamps on their circuits of greater and less voltage than the normal one, in order to determine their respective lives. Then, knowing from measurements what current each uses, it is a simple matter to determine the most efficient lamp, as it will be the one whose cost plus the cost of current used during its life is the least. Without any calculation, it is evident that an inefficient lamp with a long life may be the most economical with cheap power, and a high efficiency lamp with a shorter life where the power is expensive, as when taken from a central station. Having thus selected the most efficient lamp for given conditions the second point is to be considered. If it takes an increasing amount of power to produce the unit light as a lamp grows older it is evident that a point may be reached when the cost of the increased power may exceed the amount saved by keeping the lamp in use. Knowing, then, what this increase is, by calculation the "smashing point" may be determined—that is, the life, beyond which there is a loss to keep the lamp in use. Ordinarily, the conditions are not present which govern this case, as it assumes that the quantity of light shall always be the same. In a large installation, however, these approximately prevail, and it would not be a matter of much difficulty, knowing the rate of decrease in efficiency with the life, to take advantage of this economy by carrying out a proper system as to removals and renewals.

Wonderful Inventions. THE greatest inventors—at least in their own estimation—are generally those who claim to have found that existing knowledge in certain directions is all wrong, that everybody else has been working in the wrong direction and that his discovery or invention will therefore revolutionize matters completely; all the machines or apparatus for the same purpose must now be dumped on the scrap heap, and all the manufacturers will have to shut down or pay whatever royalty the great inventor and his capitalist may ask for, etc. Such inventors readily find encouragement from a class of capitalists who, even at the present time, still believe that money can be made in great abundance by supposed achievements which scientists tell them are beyond the limits of possibility. Such capitalists are usually beyond the reach of reason, and we have less sympathy with them than with the poor, innocent people who may be guided by their actions; they will not believe those who are able to judge correctly and the only thing that will sometimes convince them is sad experience. We have, on several occasions, called attention to some of these impossibilities in the electrical field, one of which, however, is still being used to our knowledge by an ignorant, if not an unscrupulous, inventor to prey upon capitalists, and we may therefore be justified in again calling attention to it. We refer to the fact that to obtain more than 746 watts from a horse power is as much of an impossibility as a perpetual motion; it would, in fact, be nothing more than such. Some persons who have a dangerously small knowledge of electricity seem to have the idea that this figure is based on experiments in which only our present machinery is used, and therefore by inventing an entirely new system of conversion there is a way of obtaining an entirely new and much greater equivalent between electrical and mechanical power. A little study, however, will show them that this is not the case, but that the figure 746 is obtained by simply converting one system of units by calculation into another; it is a calculation which is as purely mathematical as to find the number of cubic inches in a pint, if we know the weight of a pint of water, and that of a cubic inch; there may be a slight error in our knowledge of the weight of a cubic inch of water, but there is nothing radically wrong in the determination of this empirical constant. It is no more possible for any one to obtain more than almost exactly 746 watts from a horse power than there is a possibility of obtaining more so-and-so many cubic inches from a pint. The sooner would-be inventors recognize this the better it will be for their capitalists and for the development of legitimate electrical industries in general. Many wonderful things can be accomplished by electricity, but there are also understood limits in many directions.

What Is Electricity? To the metaphysical mind on the one hand and to the confident ignoramus on the other, the mysterious nature of electricity offers a fruitful subject of speculation. To the latter, especially, it seems a reproach that the true nature of electricity has not long before been made manifest, and he is always prepared to dash off an explanation with much more confidence than Newton proposed his theory of gravitation. It seems inexplicable to the public at large that the mystery surrounding electricity is not dispelled. The successful business man, who prides himself upon always getting to the bottom of everything, cannot understand why this one problem, as he believes, remains unsolved, and, perhaps unconsciously thinks that if his work had been in this direction, his "hustling" abilities would have produced a more favorable result than attained by scientific theorists. It does not seem to occur to those whe are impatient to have the great question, What is Electricity? answered, that we are in just as dense ignorance as to the mechanism of other phenomena. Gravitation, light, heat and chemical action are in the same category of scientific mysteries and have had centuries more of thought bestowed on them than has been devoted to the new agent. While it now seems that we may be on the threshold of one of the greatest discoveries of the human mind, yet it is possible and even probable that the knowledge of man may never be permitted to extend to the entire solution of the problem, for it is the very problem of the universe itself. Assuming what seems to be unquestioned, that electricity, electrical action, or whatever we may call it, has its seat in the atoms or molecules of matter, or of the hypothetical matter, ether, we are brought face to face with the same conditions that confront the cosmical philosopher. As the latter can never hope to have his material vision extend to the bounds of the universe neither can the molecular physicist hope to materially appreciate the ultimate elements of matter. Lord Kelvin has shown that if a drop of water were magnified to the size of the earth, one of its constituent molecules would only be magnified to approximately the size of a cricket ball. Bearing this in mind, the immensity of the problem which is so often flippantly referred to is evident. True, we may demonstrate the exact relation between electricity and magnetism, and may satisfactorily connect these with other phenomena, and even obtain a working hypothesis that will answer all scientific needs, but the ultimate solution may forever evade the human mind. Whatever we do learn, however, will not be through the speculations of metaphysicians or the guesses of tyros, but through the physical investigations of Hertzes and Teslas. While as a mental training metaphysical speculation may have its use, the absolute lack of additions to our real knowledge during the many centuries from Plato to Bacon, when metaphysics held full sway, is conclusive that nothing can be expected from this direction, and merely speculative theories in regard to the nature of electricity deserve as little consideration as is now given to the metaphysical vagaries of the Schoolmen of the Middle Ages.

Defective Flywheels.

BY W. STUART-SMITH.

The bursting of the flywheel in the power house of the Atlantic Avenue Railroad, Brooklyn, calls attention to a class of accidents that is altogether too frequent, and which can be avoided in spite of the fact that we so frequently read that "the cause is a complete mystery, but is supposed to be due to the failure of the governor to act, in consequence of which the engine ran away and the flywheel burst by reason of the high speed."

The probabilities are that in the majority of cases the governor does not give way, and there is no undue speed to account for the disaster.

I venture to express the opinion that in the majority of cases of this kind the cause lies in the fact that the wheels are not symmetrical, and that when revolving they are very much out of balance dynamically. Much has been written at different times to prove that armatures which are carefully balanced statically are not necessarily so dynamically, and calling attention to the great importance of a dynamic balance, but no one seems to have assumed that flywheels are not in perfect balance. Armatures are mounted on heavy steel shafts, are generally of comparatively small diameter, are made of tough material, arranged in the best manner to stand tangential strains, and everything is secured in the best possible manner, so that the principal reason for having a dynamic balance is to prevent undue wear on the bearings. In the case of the flywheel, however, the greater portion of the weight is in the rim, far from the centre, and is running at a tremendous speed; the material is cast iron, a brittle substance, and consequently the necessity of a dynamic balance is vastly greater than in an armature, not on account of the wear on the bearings, but because, in addition to the tangential strains which the wheel is calculated to withstand, and withstand indefinitely, it is subjected to severe side strains, and is continually weakened until finally it gives way with disastrous results. If it is not much out of balance it may stand the strain under ordinary conditions, but in case of failure of the governor to act, and a consequent great increase of speed, the unbalanced wheel goes to pieces, where a balanced one would have withstood the strain.

If a wheel is mounted so that it does not run true, that is, in such a way that the parts of the rim are forced to revolve in a continually changing plane, a strong gyroscopic action will take place, and strains be set up that are much more severe than those caused by want of symmetry alone, while a combination of the two will produce strains that are beyond the power of ordinary cast iron wheels to stand.

When cast iron wheels weighing 40 or 50 or more tons, and revolving with a peripheral speed of 4,000 to 5,000 or more feet per minute, are subjected to these gyroscopic strains they must go to pieces.

Want of symmetry in their wheels will, of course, be denied by all makers, but large cast wheels may vary greatly from causes needless to mention, as they are known to any one familiar with foundry work.

The assumption that "the governor failed to act, etc.," is without foundation in the majority of cases, as usually no one knows such to be the fact. Usually the first thing known is that the flywheel has burst, and afterward, during an investigation, no one can be found who either knew of the governor giving way or had noticed any increase of speed. It seems strange that in a station with attendants close at hand such a material increase of speed should not be noticed at once.

I have had considerable experience in the running of engines ranging in sizes from one or two horse power up to thousands, and am confident that a material increase of speed would be noticed on the instant. In some cases the governors do give way, and the increase of speed is very evident, but in most cases the burst flywheel is all there is to show, and it is assumed that the governor failed in order to account for an otherwise unaccountable thing.

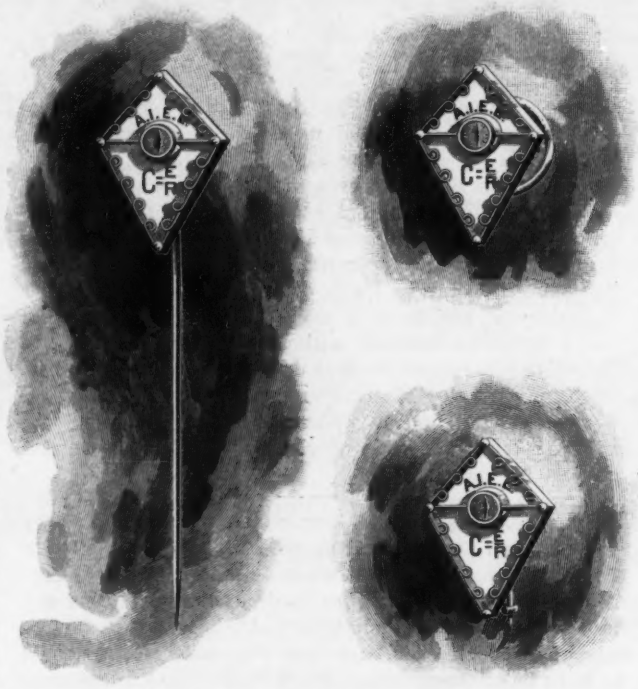
Flywheels of large size should be made of steel, when cast either as a whole or in sections, as the tensile strength of this material would enable wheels to hold together under circumstances that would be fatal to a cast iron one. Wheels of moderate size could be built up of wrought iron, the rim being made of layers of heavy plate, cut to the proper width, given the proper curvature, and the sections welded so as to make each layer of the rim one continuous piece without joint. The separate layers could be shrunk together. The inner layer would be made in sections with the ends turned down to the hub. Two adjacent pieces would have these ends dished, and the two parts bolted together, thus forming hollow elliptical spokes, which could be stiffened with a heavy cross, secured to the rim, and together with the rest of the spoke be cast into the hub. Such a wheel would be symmetrical, and if properly mounted should run indefinitely.

Cast wheels should be tooled both on the inner and outer face of the rim, and no wheel should be allowed to run which is mounted with even a little skew, on account of the gyroscopic action which would be set up.

As the bursting of a flywheel is only less destructive than the bursting of a boiler, all large wheels should be carefully tested before being put in use.

The Institute Badge.

The Committee upon Badge and Certificate of the American Institute of Electrical Engineers has completed its labors, which resulted in the adoption by the institute of a standard pin or badge, which has already been described in these columns. The badge has also been made up in a number of other forms,



VARIOUS STYLES OF INSTITUTE BADGES.

illustrations of which we present herewith, which can be secured upon application to the secretary, Ralph W. Pope, 12 West Thirty-first street, New York.

The exposed portions of these articles are made of 18-karat gold, with backing of 14-karat gold, and are of the same general character as the badge, of which several hundred have already been issued to the members. The price of the pin, lapel button, scarf pin and watch charm is the same, namely, $3; that of the single locket $8, and of the double locket $10.

The certificate of the Institute which was adopted at about the same time as the badge is now being issued. They are handsome steel engravings, and all active or full members are entitled to receive the same upon application to the secretary, and upon the payment of $2 to cover the cost of printing and engraving the same.

VARIOUS STYLES OF INSTITUTE BADGES.

National Electric Light Association

The National Electric Light Association's executive committee held a meeting in the parlor of the Lafayette Hotel, Philadelphia, Friday afternoon, Nov. 24, for the purpose of selecting a suitable place of meeting for the annual convention of the association.

The meeting was called to order by the president, Mr. E. A. Armstrong. The secretary, Mr. George F. Porter, read letters inviting the convention to meet in the following cities: Atlanta, New Orleans, Omaha, Seattle and San Francisco. A letter was also read from the California Midwinter Exposition authorities, extending a cordial welcome to San Francisco. While the advisability of holding the convention in any of the above cities was discussed, the consensus of opinion was in favor of Washington, D. C. One or two gentlemen favored Atlanta, Ga., chiefly on account of its electrical importance and the impetus that would be given to electrical interests in the South. Upon a vote being taken, the majority of the gentlemen present favored Washington, and a motion was unanimously carried to make Washington the next place of meeting, and the dates Feb. 27, 28 and March 1, 1894.

The president appointed the following gentlemen a committee on arrangements for the convention: Messrs. Baker, Royce, Bryan and Francisco.

The following committee was appointed to arrange a programme of papers to be read before the convention: Messrs. DeCamp, Price and Fairbanks.

Upon a motion made by Mr. Seely and seconded by Mr. Peck, that a committee be appointed to investigate and report the advisability of the association engaging permanent headquarters at the Postal Telegraph Building, New York City, the president appointed on that committee Messrs. Fairbanks, Seely, Peck and Baker.

The following gentlemen were present: E. A. Armstrong, president; George F. Porter, secretary; C. O. Baker, master of transportation; Messrs. H. H. Fairbanks, H. J. Smith, John A. Seely, E. F. Peck, A. J. DeCamp, R. B. Corey, A. J. Burley, George M. Phelps, of the "Electrical Engineer"; Charles W. Price, of the "Electrical Review," and D. L. Tullis, of The Electrical World. Upon adjournment the gentlemen repaired to the Union Lague Club, and partook of a banquet tendered by the president, Mr. E. A. Armstrong.

Answer to "A Query."

BY TOWNSEND WOLCOTT.

In answer to "A Query" on page 396, I would say that, according to the accepted theory of electrolysis, there would be in the case first mentioned no separation of ions. The change of partners mentioned would take place all round an endless circuit so that there could be no odd partners left over at the ends, as in the ordinary case where electrodes are used. Anything which would disturb the perfect symmetry of the arrangement, such as the diaphragm mentioned, would alter the result. If the diaphragm filled the cross section of the annular space, neither molecules nor atoms could pass it, and odd partners would be left at its surfaces. As the current is alternating, any given ion would appear in equal quantities on both sides of the diaphragm. This is on the assumption made in the query that we are working with one of those known electrolytes which are susceptible to electrolysis by alternating currents.

Laboratory Notes.—XI.

BY LIEUT. F. JARVIS PATIEN.

LOW FREQUENCY CURRENTS AND A NEW MOTOR SYSTEM.

After considering currents of very high frequency, a consideration of currents of very low frequency seems appropriate, and by the usual methods of obtaining alternating currents, it is about as difficult to obtain currents of very low frequency as it is to obtain currents of very high frequency. A two-pole generator, driven at the low speed of 300 a minute, gives 10 reversals a second, which, although low compared to ordinary lighting frequencies, is not so very low after all. On one occasion I desired to obtain about one reversal a second, and I preferred to have the current changing constantly as does a current that actually follows a sine function; it was further required that the maximum E. M. F. should not fall by reason of the low frequency, as would be the case if an alternator were driven very slowly. It is of course not difficult to drive the generator at a very low speed, but the E. M. F. falls in proportion as the speed is decreased, and the method is not satisfactory. Beautiful and novel applications often follow a study of devices of the simplest and most ordinary form, so simple in fact that unless some fortuitous chance directs the mind, they will be passed unheeded. Such a chance led to the contrivance of what I shall call "the liquid commutator," used for obtaining very low frequency currents of high voltage, and many other purposes. I have before referred to a convenient form of adjustable resistance, for use in the laboratory, consisting simply of a tub of water having a few per cent. of sulphuric acid added to it, or what is better, in some cases, a little common salt, and two movable plates or terminal electrodes, dipping into the water and so arranged as to be adjustable, both with respect to their distance apart and the depth at which they are plunged into the liquid.

Such a resistance is necessarily variable, and, therefore, unreliable as a measurer of current, the resistance decreasing rapidly as the current heats the water; but as a means of dissipating energy the device is excellent.

The "liquid commutator," which is readily derived from this device, is shown in Fig. 16. A circular trough or tub, *T T*, is provided with two conducting terminals

or electrodes P_1 and P_2, secured to the outer walls of the trough at the opposite extremities of a diameter, and these electrodes are connected, as shown, to the two mains of a source of direct current, an independent resistance, R h, determining the amount of current that is allowed to pass at a maximum. A vertical spindle, S, at the centre of the trough carries a revolving arm provided with conducting plates or electrodes, p_3 p_4, at its extremities. These plates are insulated from each other and are connected each to a ring contact carried by the spindle, on which bear brushes, to which the circuit for the desired alternating current is connected. The revolving arms and plates may be driven by any desired means; evidently they cannot be driven at a high rate of speed, owing to the sweep of the arms and the resistance of the water, but they may be moved at

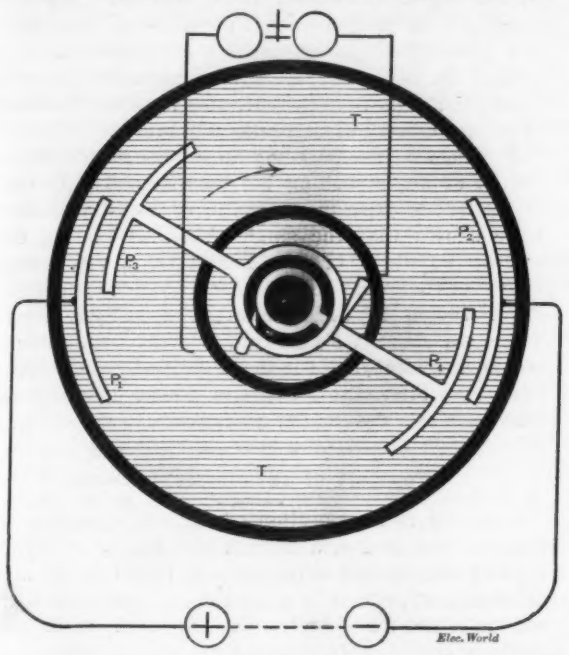


FIG. 16.

as slow a rate as can well be desired and so give a very low frequency alternating current, and by giving proper forms to the plates and properly spacing them, the current can be made to conform closely to the sine form. The apparatus is of course entirely non-inductive, and is, therefore, free from any effects of self-induction.

What is the use of such a current anyhow? Well, in answer to that, I would say the laboratory is for the purpose of trying everything, and while trying to make this apparently useless current I found one use for it that was a most agreeable surprise. It is by far the pleasantest way to administer electricity to the person that has ever come to my notice. The effect of such a current on the physical system being enjoyable as compared with the straining sensation produced by such currents as are commonly applied for therapeutical purposes. The physical effects, however, are equally remarkable, whether the current thus slowly varied in intensity is a direct current in its original form or an alternating current of a much higher frequency than that produced by the apparatus itself. The effect, such as it is, is probably due to the gradual turning on and off of the current by the revolving apparatus, thus momentarily relieving the nervous strain and as gradually applying it again. To those who habitually indulge in electric dosing I cannot too strongly commend this method of applying the current.

If comparatively low frequency currents only are desired this simple form of apparatus can be made to give two currents in quadrature, or triphase currents, if wanted, and it affords a cheap and simple way of obtaining such currents for the laboratory without any dynamo or motor transformer; but on account of the necessarily low frequency the currents thus derived would not be very satisfactory for power distribution generally.

The construction for multiphase currents hardly requires a figure for explanation. It is plain that if one circuit is taken from a pair of revolving plates at the extremities of one arm, as indicated in Fig. 16, then another circuit taken from another pair of plates carried by an arm placed at right angles to the first will have a current in a circuit connected to its rings that has zero value when the other is at a maximum.

If three single radial arms inclined to each other 120 degrees carry such plates, each having an independent ring and brush attachment, then three wires interconnected each to the other would convey triphase currents.

Another practical application of the same device is shown by diagram of the circuits in Fig. 17. By its use a simple form of motor for power purposes that is adapted to special cases can be made operative with a single phase alternating current of commercial frequency as a source of energy.

In this instance the trough, T T, is provided with 8, 12 or 16 plates instead of two, the number to be selected depending on the size of the apparatus and the distance between plates.

The figure shows 12 plates arranged in a circle, which are connected in rotation to the 12 equidistant points of a Gramme ring winding G G, provided with an interior revolving part, NS, which is given a closed circuited winding, as shown. The rings connected to the plates on the revolving arms are placed in circuit with the alternating current at the treminals of supply, and the arms are caused to revolve mechanically at a suitable rate of speed for the motor practically as fast as the apparatus will admit. The current will take the path of least resistance as the revolving arms carry the moving plates around the circle. In the position indicated a polar line is established on the vertical diameter coinciding with the position of the revolving parts, which, of course, will shift around the ring following the successive positions of the polar line. The action is, of course, similar to that of a fixed Gramme ring, having an independent fixed commutator and revolving brushes, with the exception that what corresponds to the bridging of the segments by the brushes producing a short circuit of a pair of opposite coils is in this case entirely avoided, and there will be no magnetic reactions due to such effects, and as there can be no rupture of the current at any point, there can be no sparking whatever in the operation of such a machine with either direct or alternating currents.

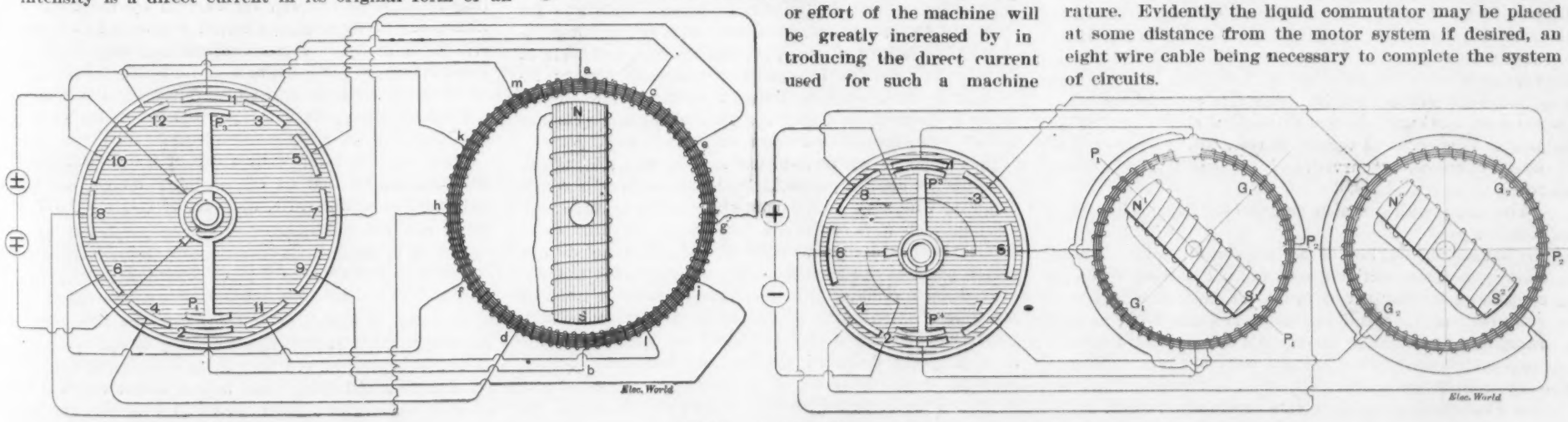
Referring again to Fig. 17, it is plain that most of the current would enter the Gramme winding at a and leave at b in the circuit connected to the plates 1 and 2; but a part would necessarily flow from the electrodes, p_3, p_4 through the circuits 3 c d 4 and 12 m l 11 in multiple arc with the first circuit. In the particular position of the electrodes indicated all these currents would tend to produce a strong polarity on the diameter a b. As the current through the circuit 12 m l 11 decreases with the forward movement of the electrodes, p_3, p_4, current gradually passes more and more through the circuit 5 e f 6, thus advancing the polar line toward the diameter e d. We thus have the effect of a true revolving field passing gradually around the Gramme ring. With slow movement of the electrodes, which is the general case with such an apparatus, the rotary torque or effort of the machine will be greatly increased by introducing the direct current used for such a machine into the circuits of the revolving part. When alternating current is used, as indicated in the figure, this closed circuit, s, upon the moving part is a true secondary to the ring winding, which then acts simply as a primary, and the motion keeps this secondary always on the line of maximum induction, i. e., the polar line of the ring, so that the induced currents in this secondary circuit will bear to those in the primary the ordinary relations of those of the secondary of a transformer at full load.

While the system just described is open to some objection by reason of the possibility of the current flowing through the machine circuits in as many as three different ways in multiple arc, still this feature may be brought, in a measure, under control by spacing the plates, 1, 3, 5, etc., a sufficient distance apart to prevent any considerable flow of current through the circuit attached to plates 3, 4, until the moving electrode is at least midway between the plates 1 and 3. This difficulty, however, is entirely overcome by the use of such a system of currents as that shown in Fig. 18, which plan also admits using a comparatively small liquid commutator, and at the same time of placing the terminal electrodes in close proximity to each other, as indicated in the figure. The system thus shown by diagram gives a true rotary field effect with a single direct current, the motor system having all the characteristics of a machine driven by biphase alternating currents, while, however, no attempt is made to transform the direct current to a biphase current, as heretofore indicated.

There are two independent magnetic systems which are caused to act simultaneously upon independent closed coil armatures in much the same way that a biphase motor is sometimes constructed by placing two independent "H," or Siemens armatures (arranged at right angles to each other on the same spindle), in a single magnetic field, and supplying the armature circuits with currents in quadrature. Those who have kept track of the different variations of the biphase machine, claimed by different inventors as independent forms, will recognize in this brief description the Kennedy motor as well as an earlier form of the Stanley biphase machine. The operation of the system of circuits in Fig. 18 is almost the exact reverse of the type of machine just referred to, and multiphase currents are not used.

The two independent magnetic systems consist of the ring field magnet G_1, with its revolving part, N_1 S_1, provided with a simple closed circuited winding and a similar ring, G_2, with a similar armature, each acting independently of the other. To cause these two systems to act as one, it is only necessary to properly alternate the current between the two and arrange the armatures on the same spindle, so that their polar lines will be at right angles, and the fields in such a way that their windings will be relatively interspaced. They are shown this way in the diagram. There are two circuits on each ring, each occupying a pair of opposite quadrants. The windings of G_2, when separately energized, cause polarities at right angles to each other—in the direction of the vertical and horizontal diameters.

Those on G_1 have a similar effect on this ring, except that the polarities caused by energizing these circuits will lie on diagonal lines equidistant between the vertical and horizontal diameters. If the circuits in the two rings are energized in rotation a continuously revolving field will result from their combined action. In the liquid commutator the opposite plates, 3, 4, and those on a line at right angles to these, 7, 8, are connected to the two circuits of the ring, G_2, the magnetic axes of which will be vertical and horizontal, as the current is switched from one of these circuits to the other. The intermediate plates of the commutator, 1-2 and 5-6, are connected to the windings of the ring G_1. As the revolving plates of the commutator are moved in the direction of the clock, current will flow first through the circuit 1-2 alone, then partly through this and the circuit 3-4 of the ring G_1, then entirely through this latter circuit, thus moving the polar line of the system as a whole from point to point around the circumference, as in a rotary field machine supplied with currents in quadrature. Evidently the liquid commutator may be placed at some distance from the motor system if desired, an eight wire cable being necessary to complete the system of circuits.



FIGS. 17 AND 18.

It is also plain that the same commutator may, by a single cable system, supply a number of motor systems, as the motors of a single shop or establishment, in which case one commutator placed at a convenient point for supervision will answer for all the motors, which will be entirely free from brushes and sparking, thus giving a single direct current motor system that has the principal advantages of multiphase current systems.

It need not be inferred that such a system is necessarily limited to a very slow speed. A form of the liquid commutator which I will not take the space to describe here, but leave for the interested student to puzzle out for himself, can be contrived on comparatively simple lines, in which the revolving plates and the water in the tub are entirely dispensed with, and the peripheral plates may be brought close together at their edges, thus removing the principal obstacles to a higher speed. These various modifications, too numerous for detailed description, are interesting only as showing what can be done with such simple devices as the original water rheostat.

On the Origin of the Factor 4π in the Expression for the Magnetomotive Force of a Coil.

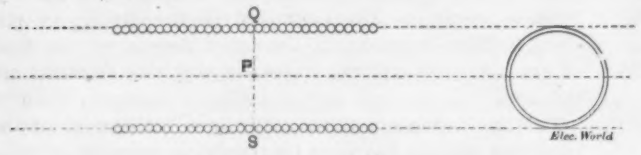
BY A. E. KENNELLY.

The magnetomotive force of a coil or solenoid is known to be $\mathfrak{F} = 4\pi NI$ C.G.S. units or gilberts, where N is the number of convolutions in the coil, and I is the current strength in C. G. S. units (of 10 ampéres), so that, expressing the current strength in ampères by i, the formula becomes

$$\mathfrak{F} = \frac{4\pi}{10} Ni \text{ gilberts.}^*$$

Since inquiries are frequently made concerning the origin and object of the coefficient 4π, we may here examine its *raison d'être*.

It may first be seen by two different methods of procedure that the intensity of magnetic flux within an indefinitely long, straight hollow solenoid is $4\pi\ n\ I$ gausses where n is the number of turns in the solenoid per centimetre of its length, and then the main proposition will be immediately deducible.



Let r (cms.) be the radius of the solenoid extending to infinity in both directions and partly represented in longitudinal and cross sections in the figure. The current I may be supposed to be constantly circulating in every turn. At any point P on the axis of the coil, the intensity is due in some degree to each of all these turns. The greatest share is provided by the nearest turn $P\,Q\,S$ immediately surrounding P. The intensity at P due to this turn alone is $\frac{2\pi I}{r}$. The share of intensity supplied by succeeding turns on each side diminishes steadily, and turns indefinitely remote obviously contribute an indefinitely small portion. The share contributed by any one turn situated at a distance x from P measured along the axis, is $2\pi I \cdot r^2 / (x^2 + r^2)^{\frac{3}{2}}$.

The total intensity at P is the sum of all the terms of this type supplied by all the turns, or in mathematical language is the integral of the expression $\left\{ 2\pi Ir^2 / (x^2 + r^2)^{\frac{3}{2}} \right\} dx$ between the limits of positive and negative infinity in the variable x. This integral is $4\pi n I = \frac{4\pi}{10} n i$, which represents the intensity at P in C. G. S. units or gausses, n being the number of turns per linear centimetre. This result is independent of the radius of the coil, and it can also be shown that the above intensity is not restricted to the axis, but has a constant value over the cross section. In other words, the intensity is uniform within the solenoid, and equal to $\frac{4\pi}{10} n i$ gausses.

It is also evident that the flux density must be uniform over the cross section of the long straight solenoid, from the fundamental principle that uniform flux density accompanies uniform flux curvature. The flux through the solenoid must follow straight lines parallel to the axis—except near the ends of the solenoid—and has therefore no curvature at any point of the cross section. Its curvature being everywhere zero, its density is everywhere equal. On the other hand, the flux through a single turn of active conductor, or a very short solenoid, is nowhere parallel or uniformly curved, and the density nowhere uniform.

The same result can also be reached independently, as follows:

The fundamental law of an indefinitely long solenoid, having unit cross sectional area and $n\ I$ current turns per centimetre is that it conveys a magnetic flux capable of producing at its ultimate extremities magnetic poles of strength $n\ I$. A unit magnetic pole is an ideal magnetic point source establishing unit intensity at a radial distance of one centimetre in every direction, and consequently all over a spherical surface of one centimetre radius, or 4π square centimetres in area. The unit pole therefore disperses 4π C. G. S. unit lines or webers, so that the solenoidal pole of strength $n\ I$ disperses $4\pi n\ I$ webers, which flux must traverse the whole length of solenoid. But the interior cross section being taken as one square centimetre, the density of this flux must be $4\pi n\ I$ webers per square centimetre, or $4\pi n\ I = \frac{4\pi}{10} n\ i$ gausses.

Returning now to the consideration of M. M. F., we have the fundamental relation $\frac{\mathfrak{F}}{\mathfrak{R}} = \Phi$, where $\mathfrak{R}$ is the total reluctance of the circuit in C. G. S. units or oersteds, and Φ is the total flux in webers, consequently $\mathfrak{F} = \mathfrak{R}\,\Phi$.

The reluctance of an infinitely long straight solenoid is all within it; for although the exterior curved paths of returning flux must be longer than the interior straight path from pole to pole, yet the exterior path is infinitely wide, so that the reluctance of the external portion of the magnetic circuit or air gap between the poles is insignificantly small by comparison. In the case then of the magnetic circuit comprised by a long solenoid whose cross sectional area is unity, the reluctance would be one oersted per linear centimetre, and if the very great length of the solenoid were denoted by X (cms.) the total reluctance of the circuit would be X oersteds to a high degree of approximation, and which would be exact for an infinitely long solenoid. We have also seen that the total flux would be $\Phi = 4\pi n\ I$ webers, and consequently,

$$\mathfrak{F} = X \cdot 4\pi n\ I \text{ gilberts.}$$

but $n\ X = N$ is the total number of turns in the solenoid so that $\mathfrak{F} = 4\pi N I$, and the M. M. F. is 4π multiplied by the current turns, or $\frac{4\pi}{10}$ multiplied by the ampère-turns on the circuit.

This rule for arriving at the M. M. F. of an indefinitely long straight solenoid, in which the air gap reluctance is indefinitely small, applies immediately to a closed or endless solenoid—of the ring type—in which no air gap exists. It also extends generally to any form of magnetic circuit, including or excluding iron. In general, however, the reluctance of such circuits and the intensity within them will be very complex, but any loop of conductor carrying a current of i ampères may be regarded as developing a separate M. M. F. of $\frac{4\pi}{10} i$ gilberts.

* The terms gilbert, weber, oersted and gauss are here introduced tentatively, for the C. G. S. magnetic units of magnetomotive force, flux, reluctance and intensity.

Single-Phase vs. Two-Phase Systems.

BY ELIAS E. RIES AND GORDON J. SCOTT.

In the issue of The Electrical World of Nov. 18, 1893, appeared a short note on the two-phase system, in which Dr. Louis Bell was quoted as having said at Chicago: "When you have got an alternating current you can do something with it." To which Mr. Rankin Kennedy adds: "When you have got two alternating currents in quadrature you can do ten times more with them."

The only fault to be found with Dr. Bell's statement is that it was not made emphatic enough, judging from the additional remarks that Mr. Kennedy seems to find it necessary to make.

Dr. Bell evidently had in mind the facility and economy with which the alternating current could be generated, transmitted and converted at will into currents of any desired potential best suited to the translating device or devices at hand, whether the latter consist of lamps or motors, or both, whereas Mr. Kennedy doubtless had in view the more specific application of the current to two-phase motor work, erroneously believing that on alternating current circuits efficient motor work could only be accomplished by currents differing from each other in phase.

A little reflection will show that even in the case of motor operation a simple alternating current should possess, theoretically, the same capacity for doing work as a two-phase or multiphase current, or even a continuous current representing an equal amount of energy. That this has not heretofore been practically accomplished with simple alternating currents is due to a failure to grasp the correct principles upon which the single-phase current must be made to act in order to produce efficient results, and consequently to the faulty and imperfect construction of single-phase motors so far designed in attempts made to solve this important problem. This failure is largely, if not entirely, traceable to a misconception of the peculiar magnetic actions involved in the operation of such a motor and to ill-considered attempts to apply the results of direct current practice to alternating motor work.

In two-phase or three-phase motors the alternating currents are applied periodically and successively through separate windings, each capable of actively contributing its quota of work during a portion of the time only. There is thus a considerable period of time during which parts of the machine are practically idle, thereby preventing the material in the same form being used to its fullest extent and necessitating a correspondingly larger machine for a given output. On the other hand, in a properly designed single-phase motor the entire machine is active at all times, the alternating current in such a motor being usefully employed throughout its entire phase and all the material in the machine continuously utilized to its greatest extent. We have built and have now in successful operation a number of single-phase alternating current motors of this kind, which run on circuits of comparatively high frequency, with results that compare favorably with the best direct current practice in the matter of efficiency, and which far surpass direct current and polyphase motors in regard to simplicity, low weight and general excellence of operation.

The work that can be obtained from two-phase or three-phase currents, or in fact from any multiphase system, does not exceed that obtainable from a single-phase alternating current, whereas the greater simplicity and economy of the latter as regards both installation and operation, and its comparative freedom from the limitations to which the other systems are more or less subject, render it in every way superior for nearly all classes of work. The results that we have obtained show that it is entirely practicable to make a simple alternating current act upon itself in a single-phase motor in such a manner as to produce all the effects of a commutated or partially commutated current, without the employment of any extraneous devices whatever, and yet permit both the speed and efficiency of the motor to be perfectly independent of the speed of the generating dynamo and the frequency of alternations of the current.

If Dr. Bell had said, "When you have got an alternating current, you can do everything with it that electricity can accomplish, and do it better than in any other way," he would have struck the mark nearer the centre. All natural phenomena with which physicists are acquainted involving the transmission and utilization of energy in its most perfect form, whether the same consist of light, heat, sound or electricity (and probably magnetism and gravitation as well), are directly due to and dependent upon vibrations of some simple form, either rotating, oscillating, undulating or alternating in character. It is therefore reasonable to assume, even if it were not already demonstrated, that the generation, conversion and utilization of electrical energy can be most perfectly accomplished by means of a simple alternating current, and that the commutation or superimposing of currents as heretofore practiced can only be considered as being an imperfect and transitory means of accomplishing the desired ends. The results of numerous experiments made by us in this direction have shown that the single-phase alternating current system possesses greater flexibility, higher efficiency, more convenience, and requires less complication and lower weight in the translating apparatus, than any other. In short, we find that a great deal more work can be accomplished, for the same weight of apparatus, with two alternating currents whose phases coincide than with two that are in quadrature.

Economy of Incandescent Lamps.

Referring to the question of the life and economy of incandescent lamps, a French electrician writes: "The type of lamp suited to factory use, in which the amount of energy expended is a matter of small moment, is not suitable for installations supplied from central stations charging for current by meter. Lamps made for long life, without regard to economy of current, have filaments relatively large and give the quantity of light for which they are made at a lower temperature than in those lamps in which economy of current is an important consideration. On the other hand, in lamps made to economize current, the light is produced by raising the filament, which has a smaller surface, to a higher temperature, and it therefore follows that the light emitted from lamps of the latter type are more brilliant than those made for long life. In order to render the filament at this higher temperature more durable greater care is expended in its preparation, and more costly and entirely different processes employed than in the manufacture of filaments for ordinary incandescent lamps."

He then makes the following interesting calculation and comparison between high and low efficiency lamps:

"Ordinary 16-c. p. lamps consume, as a general rule, 3.5 watts per candle, or, say, 56 watts per lamp. At 12 centimes the hectowatt, or 24 cents the kilowatt (the usual price charged for current by the Paris stations), one of these lamps would consume in 100 hours 6.72 f., or $1.344 of current. Admitting that the life of these lamps is 1,000 hours and that they cost 1.80 f., or 36 cents, we must add 18 centimes per 100 hours, or a total of 6.90 f., or $1.35 per 100 hours for each 16-c. p. lamp.

"Take another lamp with a life of 500 hours, or only half as long as that of the ordinary lamps, having a consumption of 43 watts, the cost of this lamp for 100 hours will be

	Francs.	
Current at 12 centimes the hectowatt.....	5.16	or $1.03
Replacing lamp at 2.50 f. or $0.50 per 500 hours.	.50	.10
	5.66	$1.13

or a saving of 1.24 f., or 25 cents for each 100 hours by the employment of the high efficiency lamp.

"Consequently, an ordinary lamp consuming 3.5 watts per candle and lasting 1,000 hours, would entail a loss to the consumer of 12.40 f., or $2.50, although the lamp lasting twice as long in the first place cost 70 centimes, or 14 cents, more than the high-efficiency lamp, and lamps of 10 or 32 c. p. would show a proportionate economy.

"If the long-life lamp has been supplied without charge, and the high economy lamp costing 2.50 f., or 30 cents, be compared with it, the consumer would, by using the latter, save 10.60 f., or $2.12, in 1,000 hours, as shown in the following calculation:

"Consumption of ordinary 16-c. p. lamp at 3.5 watts per candle burning for 1,000 hours:

	Francs.	
16 by 3.5, 56 watts by 1,000, 560 hectowatts at 12 centimes	67.20	$13.44
Total	67.20	13.44

"Consumption of high-economy lamp 16-c. p. at 2.7 watts per candle for a life of 1,000 hours:

	Francs.	
16 by 2.7, 43 watts by 1,000 hours, 430 hectowatts at 12 centimes	51.60	$10.32
Two 500-hour lamps at 2.50 f., or 50 cents....	5.00	1.00
	56.60	$11.32

or a saving of 10.60 f., or $2.12, by the use of the high-efficiency lamp.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

(Compiled from the principal foreign electrical journals.)

BY CARL HERING.

ELECTRO-PHYSICS.

Permeability and Inductive Capacity.—In an editorial in "Ind. and Iron," Nov. 10, which is interesting reading, a perfect electric conductor and a perfect magnetic conductor are discussed showing some curious results, which are of value in showing more clearly how closely the two circuits are related, thus "making the elementary ideas of the electro-magnetic theory of light more easily understood." It discusses the properties of an impermeable substance and an infinitely elastic dielectric; according to Maxwell a perfect conductor of electricity would be impermeable; a ring of perfectly conducting metal would inclose a constant number of lines of induction; any attempt to change the number of lines would produce an infinitely large current, and it would therefore be impossible to increase or diminish the total induction; if the ring were formed with no induction through it to begin with, it would never have any induction through it afterward; if the pole of a magnet were pushed through it the current produced would be large enough to demagnetize the magnet; the secondary in a transformer may be regarded as a coil which tends to prevent the core being magnetized, and if it had no resistance and no self-induction it would be impossible to magnetize the core. Similar deductions are made in the case of a plate of perfectly conducting material; it shows that a material which has infinite electricity is magnetically impermeable, and if a ring of this material be interlinked with an electric circuit, it would form a choking coil of infinite self-induction, in which it would be impossible to start a current; the ring of magnetic metal is the strict analogue of the ring of a perfect conductor. A plate of this magnetic material is then considered as a dielectric in a condenser, and it is shown that it would be impossible to produce electrostatic induction through a sheet of a perfect magnetic conductor. Electrostatic and magnetic circuits are therefore analogous in so far that a perfect electric conductor would be impermeable, and a perfect magnetic conductor would have no inductive capacity, and would be an insulator.

Electricity.—The Lond. "Elec. Eng.," Nov. 10, contains Mr. Walker's fifth article on "What Is Electricity?" in which he discusses "The Link Between Electricity and Magnetism;" in order to grasp his idea he considers it necessary to make "a somewhat bold but a grand conception;" he conceives magnetism to be stored energy in the form of a vibration of a special time and form peculiar only to such bodies as iron, nickel and cobalt; he thinks it probable that the magnetic vibrations within a magnet are in the form of continuous waves from one end to the other which are taken up by surrounding ether which transmits them to another magnet as a pushing or pulling force, and that lines of force are merely the communication by the ether of this pushing or pulling force; conduction is merely the transmission of the vibration which he conceives electricity to be, and electromagnetism he conceives to be its transmission in waves surrounding a conductor; the wave within the conductor proceeds onward at a very different rate from the one surrounding the conductor.

Velocity of Propagation.—"L'Ind. Elec.," Nov. 10, and "La Lum. Elec.," Nov. 11, reprint an Academy paper by Mr. Blondlet on a determination of the velocity of propagation of an electric perturbation through a copper wire, by the aid of a method which is independent of any theory; a cut is given showing the arrangement of the apparatus.

Electric Transference of Heat.—In a couple, made for instance of Fe-Cu-Cu-Fe, the E. M. F. is zero, but if the iron at one of the junctions is magnetized an E. M. F. will be generated; when the current is thus produced energy must in some way be absorbed; in an Academy of Sciences paper, reprinted in "L'Ind. Elec.," Nov. 10, Mr. Houllevigue describes his researches, showing that the source of the current is due to the absorption of heat.

Transmission through Air.—The article mentioned in the Digest, Nov. 18, is concluded in "La Lum. Elec.," Nov. 4, in which are given additional tables and curves of results and the final conclusions.

Symbols and Terms.—The Lond. "Elec. Rev.," Nov. 10, discusses the recent article in "Nature" by Dr. Lodge, on this subject.

Differential and Integral Calculus.—The Lond. "Elec.," Nov. 10, contains a short, well written article explaining in simple language the object and meaning of differential and integral calculations in determining "rates" and in "summing up," for which purpose they are often of great use in electrical calculations.

UNITS. MEASUREMENTS AND INSTRUMENTS.

Units of Heat and Temperature.—An article in the Lond. "Elec.," Nov. 10, calls attention to the fact that heat and temperature are not among the quantities which are defined in the C. G. S. system. It states among other things, that Prof. Forbes and Mr. Preece suggested to use as the heat unit the equivalent of the energy of one watt for one second, that is one joule, and that the unit of temperature could be the rise of temperature which one gramme of water would undergo if the amount of heat of one joule was communicated to it; in that case one degree C would be equal to 4.2 degrees of temperature on this new scale; one objection was that the mechanical equivalent of heat was not known with sufficient accuracy, but this objection has now been removed by the recent redetermination of Mr. Griffiths (see Digest, Sept. 16 and 23); another objection is that the specific heat of water is not the same for all temperatures; belief is expressed in the article that there is no probability that a substance exists for which this definition would be applicable, but as early as 1854 Sir W. Thomson showed that it was possible to deduce what the behavior of a perfect gas would be, and thus to determine the temperature in a manner independent of the peculiarities of any special substance (see also Digest, July 22 and Aug. 19).

Dimensions of the Absolute Temperature.—The discussion on this subject (see Digest, July 22 and Aug. 19) is continued in "L'Ind Elec.," Nov. 10, in a letter by Mr. Guillaume.

Electric Pyrometry.—The Lond. "Elec.," Nov. 10, gives an abstract of a Society of Arts paper of March 6, by Prof. Austen, in which he gives a resume of the subjects, describing and illustrating the Siemens and Callendar apparatus; the paper appears to contain nothing new; he is satisfied that the thermo-junction will give reliable results at temperatures of over 1,000 degrees C. accurate to one degree.

Resistance Measurer.—In the serial of Messrs. Niblett and Ewen, in the Lond. "Elec. Eng.," Nov. 10, an illustrated description is given of the resistance measurer of Siemens devised a number of years ago.

Phase Meter.—The apparatus described in the Digest, Nov. 4, is illustrated in the Lond. "Elec.," Nov. 10.

Weston Instruments for Railway Circuits.—In "L'Elec.," Nov. 4, Mr. Meylan gives a good technical description and discussion of the Weston instruments for railway circuits.

DYNAMOS AND MOTORS.

Alternators in Series and Parallel.—In a mathematical article by Mr. Whitwell, in the Lond. "Elec. Rev.," Nov. 10, he discusses the subject of two alternators, driven independently and connected in series, representing his concluding equations by means of curves; he finds that for any difference of phase "between 0 and π. the lagging alternator is doing more work than the other; as the alternators are driven independently, the lagging one will, therefore, tend to slacken its speed, and the leading one to quicken, consequently the difference of phase will increase until it becomes π. If the difference of phase is anything between π and 2π, the leading alternator is doing more work than the other, its speed will therefore slacken, and the difference of phase will tend to become π; in other words if the phase difference is a little more or less than π it becomes π; hence two equal alternators driven independently in series settle down into opposite phases and do no work. Regarding alternators connected in parallel, for which he also shows the curves, he finds that for any difference of phase between 0 and π the leading alternator is doing more work than the other, it will, therefore, tend to slacken speed, and the lagging one will tend to increase its speed, consequently, the difference of phase will become less, this will go on till the difference of phase is zero, and this will be a point of stable equilibrium. For any difference of phase between π and 2π, the lagging alternator is doing more work than the other, it will therefore tend to slacken and the leader to increase its speed so that the difference of phase increases until it reaches 2π, which is the same thing as zero; hence alternators independently driven in parallel get into step and tend to keep together, a result opposite to that which is obtained when they are in series.

Non-synchronous Motors.—In a letter to "L'Ind. Elec.," Nov. 10, Mr. Leblanc claims that he and Mr. Hutin are the true inventors of non-synchronous motors, and that they had established the complete theory; also that they were the first inventors of the electrolytic condenser; they also state that they have invented a new apparatus not yet described, which is superior in every respect to the others.

Arc Lighting Dynamos.—In his serial on arc lighting in the Lond. "Elec. Rev.," Nov. 10, Mr. Carter describes and illustrates the Statter dynamo, in which the regulator moves the brushes to keep the current constant; also the Brush machine, of which a number of detailed illustrations are given.

Alioth Alternator.—The "Rev. de L'Elec.," Oct. 31, describes and illustrates a new form of this machine.

TRANSFORMERS.

Replacing Old by New Transformers.—In an article by Mr. Claude, in "L'Ind. Elec.," Nov. 10, he discusses the all-day efficiency of transformers, showing how much transformers have been improved in this respect during the last few years; from this he concludes that it would be a great advantage in many stations in which old transformers are used to replace the old by new ones, and he shows by figures taken from actual cases how very great the saving would be; in the case cited he finds that there will be a saving of 570 watts in a 7.5-kw. transformer, making from 7 to 13.5 kw. hours saving per day for every transformer; he believes this gain is not appreciated by many, and states that the expense of changing the transformer would be saved in a very short time.

ARC AND INCANDESCENT LIGHTS

Candle Power of Search Lights.—Mr. Hospitalier in "L'Ind. Elec.," Nov. 10, reprints Mr. Steinmetz's letter to the Lond. "Elec.," and the editorial comments on the same (see The Electrical World, Nov. 18, page 392), and states that the errors or misconceptions in this case are again due to incorrect definitions of the quantities used in measuring; it is absolutely impossible to compare and express as a function of a single and the same unit the intensity of a luminous point and that of a bundle or beam of parallel luminous rays. He makes an analogy by comparing a luminous point to a magnetic pole and a luminous beam of parallel rays to a uniform magnetic field; the intensity of a magnetic pole is similar to a flux of magnetic force, while the intensity of a field is the quotient of a flux and a surface; these two physical quantities are of a different nature and have no common measure; to express the intensity of a pole by a magnetic field of a given intensity is not rational, and the same is true of the photometric analogy; considering even the divergence of the rays and the imperfections of the projectors, a photometric measurement has no signification, on account of the want of the physical identity of the magnitudes; he agrees with the "Electrician" that the values of the luminous intensities given in connection with lighthouses and projectors have no physical meaning.

Maximum Efficiency of Arc Lamps.—Mr. Crompton, in the Lond. "Elec. Rev.," Nov. 10, criticises Prof. Carhart's Congress paper on "The Maximum Efficiency of Arc Lamps with Constant Watts," stating that he believes the conclusions to be erroneous, as the results differ very widely from those obtained by himself; Crompton obtained from 42 to 43 volts as the limits between which the maximum efficiency lies; he acccounts for the discrepancy in that Prof. Carhart used American carbons, while in his experiments he used German carbons; with cored positives and solid negatives of German make the light-giving efficiencies obtained are greatly superior to those found by Prof. Carhart; by using the same size of carbons for top and bottom long arcs would give better results than short ones; he believes that the "greatly improved efficiencies" obtained in Europe are partly due to the use of large cored positives and small solid negatives; with 450 watts and 42 volts at the arc, the mean candle power in the lower hemisphere was 1,650 candles, which is about 50 per cent. better than that obtained by Carhart.

Incandescent Lamp.—The fundamental patent expired in England Nov. 10; in commenting on this in a long editorial, the Lond. "Elec.," Nov. 10, credits Lane Fox with the first suggestion, in October, 1878, of high resistance lamps in parallel, and to Swan, February, 1879, the invention of the successful lamp; the inventions of Mr. Edison are criticised very unfavorably. Among other things it states that "the crowning absurdity of the patent which expires to-day is that no lamp has ever been known to have been made in accordance with its directions except for purposes of litigation. . . . To-day the least vestige of a connection between Mr. Edison and the carbon glow lamp is swept away. . . . Now that the tar-putty patent is no more, nothing stands between Mr. J. W. Swan and the honor of the invention of the carbon glow lamp."

Arc Lighting.—The reply of Mr. Carter in the Lond. "Elec. Rev.," Nov. 10, to Mr. Carhart's statements contains nothing of general interest.

Arc Lamp.—The Puteaux lamp is illustrated and described in "L'Elec.," Nov. 4.

Portable Electric Lamp.—The Lond. "Elec.," Nov. 10, mentions the Sussmann lamp recently exhibited at a Miner's Institute, which is about the size and weight of a miner's "Davy" lamp, giving about three candles; a storage battery is used which is stated to be absolutely dry; it will run for 16 hours with one charge.

Fredureau Diffuser.—In "L'Elec.," Nov. 4, Mr. Haubtman gives the first part of an article on these diffusers, calling attention to the advantages; in a subsequent article he will give the theory and a description of their construction.

TRANSMISSION OF POWER.

Transmission of Power.—Prof. Unwin's sixth lecture on "Distribution of Power by Gas and by Electricity" is given in abstract in the Lond. "Elec. Rev.," Nov. 10. Under the former he describes the electric lighting station at Dessau; he mentions briefly gas supplied for heating and power and gives tables showing the power that can be transmitted by means of lighting and Dowson gas at a distance of 5,000 feet for different sizes of pipes. Regarding the electrical transmission of power he states that "no doubt electrical transmission of power to great distances is possible," but gives as a condition that 20,000 to 40,000 volts or more must be used or the cost is excessive, also that the use of such currents seem likely; in dealing with electrical distri-

bution he says one thing has been forgotten which is "that there have always been other means of transmitting power to great distances." "Financially, electric lighting operations appear to be succeeding, though it is too early to estimate the measure of their successes." He admits that remarkable success has been achieved in electric railways, but that "the cost of electric traction is not much lower than the cost of horse traction;" he appears to attribute the success simply to the greater speed; as a case where electricity is likely to be used very successfully, he cites underground and overhead railways, in which he admits that it is possible that even in working cost the electric motor will be superior to the steam locomotive; regarding power from lighting stations he states that "in a very few cases power is taken from electric lighting mains" (he is evidently not acquainted with the fact that in this country power is used very largely from electric lighting mains); he claims that even if electricity were sold at half price for power purposes the cost would be greater than that of steam or gas power (why then should so much power be used from lighting circuits even at double this price?). He claims that it is probably only where water power is available and where cheap overhead transmission is possible, that electricity can compete with other sources of power. He concludes that the advantages of the electric system are as follows: Simplicity in the transmission between engine and motors; saving of loss in running an intermediate system constantly, where little or no work is being done; greatest efficiency of transmission even with full load; facility of effecting future extensions with the smallest modification of existing plant. He describes briefly the transmission at the Comstock mines, at Genoa, and at Heilbron; regarding the latter system of double transformation of three-phase currents, he states that it is an expensive method. His statement in describing the Genoa installation that "the line has a resistance of about 500 volts," we hope is a typographical error.

Prof. Unwin's fourth lecture on "Hydraulic Trans mission" is continued in the Lond. "Elec. Eng.," Nov. 10.

Application of Electric Power.—In an article in "L'Ind. Elec.," Nov. 10, Mr. Lafargue discusses the subject of the advantage of using individual electric motors in a workshop to replace the usual mechanical transmission from the steam engines to the machines, basing his remarks on a paper by Mr. Hartmann, of the General Electric Company, of Berlin, read before a German society last year; he gives numerous figures for various forms of transmission, and makes comparisons: in an actual case the gain in favor of an electrical transmission in a brewery was 31.1 per cent.; in a table he gives a number of figures from which he deduces the economy in favor of electricity, which varies from 10 to 80 per cent., with an average of about 35 per cent.: similar figures are given for elevators run by gas engines, municipal water supply and electric motors, showing an appreciable economy over the first and a very great economy over the second. In conclusion he illustrates several machines and describes them. (See also Digest, April 1, under Motors, and May 6, under Transmission of Power.)

Accumulators vs. Coal.—Mr. Moutier, in an article on the miners' strike, in "L'Elec.," Oct. 28, discusses the question of power and the dependence of industries on coal, and calls attention to the advantage of using wind and water power instead, transmitting it electrically: he makes a calculation of the cost of transportation of the energy in the form of coal or stored in accumulators, and finds that up to a radius of 50 kilometres (30 miles) it would be cheaper to store the energy in accumulators and transport it in that form, but beyond 30 miles it is cheaper to transport the coal.

ELECTRIC RAILWAYS.

Accumulators in Power Houses.—In an article on the railway at Hirslanden, the Lond. "Elec.," Nov. 10, states that the Oerlikon Company is experimenting with the use of accumulators at the power station to balance the load; it mentions an article by Dr. Schoop, in which attention is called to the greater economy of steam engines at full load, even though the first cost of the plant is often the same, with or without accumulators, although in the former case the engine and dynamos can be reduced to one-third or one-half of the capacity. In this plant there is a steam engine of 50 h. p. and a battery of 270 cells of a capacity of about 150 ampere hours capable of discharging at 35 amperes during three or four hours, or 75 amperes for one hour; if necessary 110 kw., or 75 h. p., may be taken from the battery for not more than five minutes at a time; 81 of the end cells are used for regulating; the article states that perhaps the principal advantage is that this enables a water power to be used which under other circumstances would not suffice.

Power House Engines.—The Lond. "Elec.," Nov. 10, in commenting on the report at the Milwaukee meeting of the Street Railway Association on this subject, states that while there appears to be a decided fitness in direct coupled dynamos for electric lighting stations, it is not so for large railway power houses; in the former the change of load is so gradual that a very large part of the plant may be shut down for long periods, but in the latter the load diagram is quite different, and it is not possible to shut down any but the reserve plant; extensive subdivision and small units are therefore inappropriate; for moderate powers it is practicable to design steam engines for direct coupling, but when the unit of power is very much larger it is often found impracticable to adapt the steam engine to the high speeds which dynamos should have, and costly to adapt the dynamo to the slow speed of the engine.

High Speed Railroading.—Referring to the proposals of Mr. Behr, noticed a number of times in these columns, the London journals of Nov. 10 state that the Thames Iron Works and Shipbuilding Company has made arrangements for carrying out experiments on a large scale on this system, with a view to perfecting the electrical details.

Motor Gearing.—The serial in the Lond. "Elec. Eng." (see Digest last week) is continued in the issue of Nov. 10; various forms of gearing are discussed without, however, giving anything new.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Large Proposed Installation in Saxony.—The "Elek. Echo," Nov. 4, reprints a notice from a Dresden daily paper, from which it appears that a project is being considered to supply the whole kingdom of Saxony with electricity from a single central station, situated at a coal mine south of the city of Dresden; 168 towns are to be supplied, and high tension alternating currents are to be used.

Copenhagen.—The station at Copenhagen is described in Lond. "Elec.," Nov. 3; the arrangement common in Germany is used, consisting of the three-wire system in connection with accumulators; numerous diagrams and views are given.

Westminster.—The Lond. "Elec. Eng.," Nov. 10, continues its description of the Westminster station.

Train Lighting.—The article on train lighting in the "Rev. de l'Elec." is concluded in the issue of Oct. 31; with the exception of what has already been given in these columns, it is of merely local (Switzerland) interest.

Lightning Arresters.—"L'Ind. Elec.," Nov. 10, contains the first part of an illustrated article by E. H., describing, with the aid of illustrations, the different forms of lightning arresters used in America.

Automatic Maximum Current Interrupter.—A translation in abstract of an article under this heading illustrated in the Digest, Aug. 5, is given in the Lond. "Elec. Eng.," Nov. 10.

WIRES, WIRING AND CONDUITS.

Cable Coupling.—The Bowden coupling is described in the Lond. "Elec.," Nov. 10, six cuts being given; it is intended for dividing high pressure cables into sections so that any portion of the main can be cut out and worked upon, without interfering with the supply of current on the remaining portion; the cable can be disconnected in a few minutes without danger; the joint is said to be perfectly watertight; it consists essentially of two sets of coupling nuts, an inner one for conductors and the outer one for pressing together the large and specially formed ends of the rubber insulation. It has been in use in England for 18 months.

Regulations Regarding Lines.—Most of the recent French journals give at considerable length the recent rules and regulations of the French government regarding electric lines in or on public streets and roads.

Chemical Analysis of Gutta-Percha.—"La Lum. Elec.," Nov. 11, contains an article on this subject by Mr. Rigaut, describing an illustrated apparatus for the quantitative analysis of gutta-percha.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Simultaneous Telegraphing and Telephoning.—The "Zeit. fuer Elek.," Nov. 1, describes the Picard process which is used in France, and is there replacing the Van Rysselbergh process, as it is better adapted to the Baudot printing telegraph. From the cut it appears that the telephone line must be metallic; what is called a differential transformer is introduced into the circuit, consisting of a primary and secondary, each of which is divided into two equal parts; the two outside terminals of one are connected to line, and the two outside terminals of the other, with the telephone apparatus; the single line to the grounded telegraph instrument is connected to the middle point of the coil which is connected to the line; the telephone current is simply transformed, but the telegraph current divides equally between the two parts of the secondary coil and therefore produces no effect on the telephone current.

Telegraphs in India.—The Lond. "Elec.," Nov. 10, gives a short statistical article for the years 1892-93.

ELECTRO-CHEMISTRY.

Electrolysis of Salt.—In a short anonymous article in the Lond. "Elec. Rev.," Nov. 10, it is stated that no practical data based on the continual use of porous partitions appears to exist; regarding the use of mercury as a cathode, it states that the sodium requires a higher electromotive force to liberate it than hydrogen does, and it therefore represents a greater expenditure of fuel, also that it is almost impossible to avoid the liberation of hydrogen, which makes an explosive mixture with chlorine; it is questioned whether mercury is practicable in alkali manufacture; it claims that the only form of apparatus of which there is any hopes is that in use at Snodland; the life of gas retort carbon as an anode in common salt solutions has proved to be over a year; the average efficiency is based on 210 ampere hours per pound of salt, which is considerably over 80 per cent.; the voltage has been brought down to four volts in tanks of 60 cubic feet capacity, and with a current of 500 amperes.

Barium and Strontium Binoxides.—The "Elek. Tech.," Oct. 31, describes the electrical process of Taquet of Paris; anodes of iron are used, and by the action of the chloride of iron solution formed, these alkaline earths are reduced from carbonates and sulphates; the process is said to be cheaper and simpler than the usual one; these compounds are used for the manufacture of potassium hydrates and for extracting sugar from molasses and syrups; it is stated that from 1.5 to 2 kilograms of BaO is obtained per horse power hour, also that almost pure potassium hydrate is obtained; it is said to completely solve the problem of the extraction of sugar from molasses residues.

Bleaching with Ozone.—The "Elek. Tech.," Oct. 31, describes a process in which the bleaching is accomplished by a combination of ozone and chloride of calcium, which it is claimed does not destroy the fibres of the cotton to be bleached, but there appears to be nothing electrical in the process.

Chloride of Lead Accumulator.—Referring to Mr. Lloyd's recent paper read at the Franklin Institute, Mr. Andreoli, in the Lond. "Elec. Rev.," Nov. 10, states that he was the first to make plates of chloride of lead fused or cast on a lead or lead alloy grid; his experience with a chloride of lead battery shows that it is equal, if not superior, to the usual lead oxide solutions; he states that the process described in that paper is neither the cheapest nor the best, stating that the chloride of zinc is unnecessary, as there are cheaper ways of rendering the plates more porous; he says it may be claimed that such electrodes as he has lately adopted hold more active substances imbedded in the cells of their grids, and are more conductive than the plates made in the usual way.

MISCELLANEOUS

Electrical Concentration of Vitriol.—Mr. Blount, in the Lond. "Elec.," Nov. 10, calls attention to the fact that the actual cost of energy in many commercial operations is often very small and therefore of much less importance than is often given it; he then discusses the subject of the concentration of vitriol by means of electric heat, and refers to a paper in the "Chemiker Zeitung," by Mr. Bucherer, in which it is discussed in detail. To concentrate 117 kilograms of acid at 60 degrees B. into 100 at 66 degrees B., 44.2 h. p. hours would be required theoretically, which at the farthing rate is about 10s. per ton, which compares unfavorably with the cost of heat supplied directly from a furnace; the heat would be applied by means of a platinum wire and either direct or alternating currents, care being taken not to exceed five volts in order to avoid electrolysis; a wire .5 centimetre in diameter and 77 centimetres in length would require a current at 364 amperes at five volts to concentrate 24 kilograms in five hours; the theoretical cost of the fuel at 10s. per ton, would be 0.2s., that for direct heating 2s. and for electrical heating 10s.; he believes that the economy of electrical concentration is more than doubtful.

Percussion Drill.—In "La Lum. Elec.," Nov. 11, Mr. Farman describes the principle of his new electric drill, and shows by means of an example how its proportions may be calculated. In a separately excited field a Gramme ring armature will rotate to the right or to the left according to the direction of the current, the brushes being at the theoretical neutral points; suppose the ring to be cut and straightened, forming a straight bar wound with a short-circuited coil, and suppose the magnetic field be likewise cut and placed in the same relative position around the straight bar; a current led to the coil encircling the bar, by means of brushes, will then in the same way produce an axial motion of the bar, depending on the direction of the current; the reciprocating motion in his drill is based on this principle; the article contains several cuts, all of which are diagrammatical.

Mechanical Applications of Electricity.—In Mr. Richard's well illustrated serial in "La Lum. Elec.," Nov. 11, he describes and illustrates, among a number of applications, several mining drills.

Artificial Rain.—In a note in "L'Ind. Elec.," Nov. 10, Mr. Baudouin stated that on a certain day he made electric contact with clouds about 4,000 feet distant by means of a kite, and at the same moment there appeared a local fog, after which drops of rain fell; when the contact was broken by withdrawing the kite, it ceased; he states that in 1876 he produced rain several times in the same way in a plateau on the frontier of Tunis; (but he does not state how often his experiment was unsuccessful).

Starter and Recorder for Races.—The Lond. "Elec. Eng.," Nov. 10, discusses and describes a new arrangement for starting and recording races.

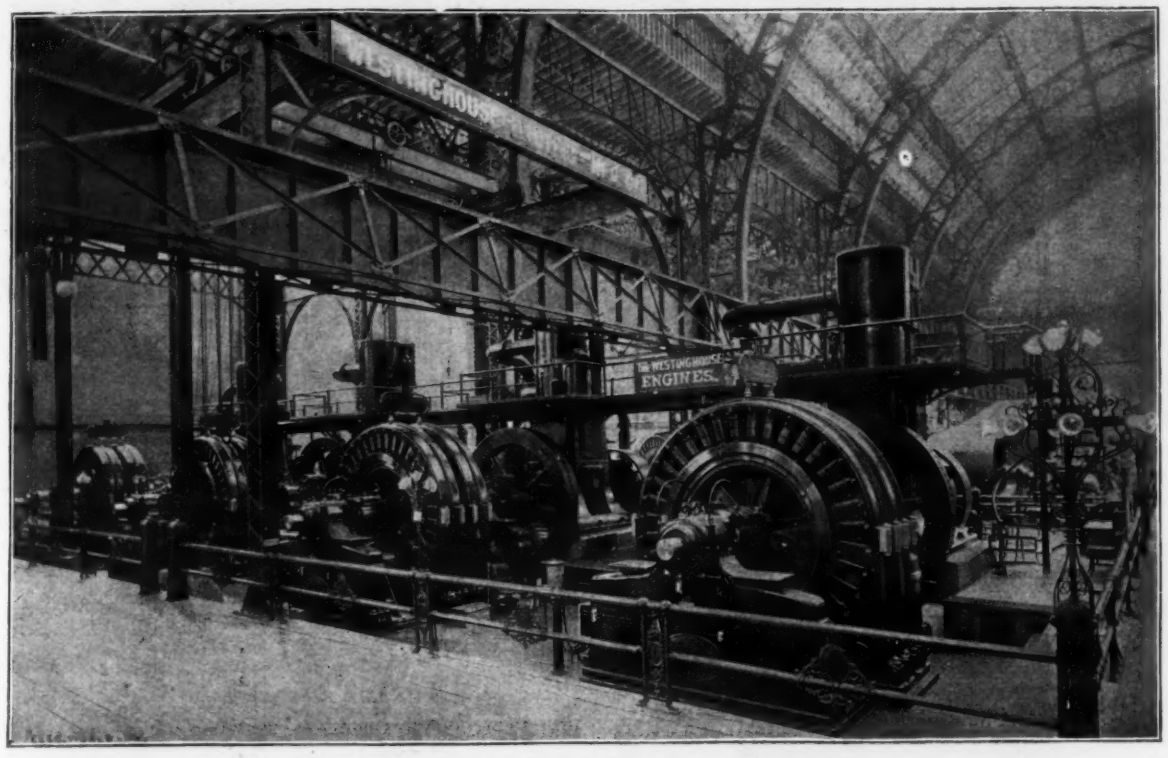
Biographical.—The Lond. "Elec.," Nov. 10, publishes a short biographical sketch of Joseph Wilson Swan, whom that journal credits with the invention of the incandescent lamp; it is accompanied by a large well executed portrait.

Educational.—The Lond. "Elec. Rev.," Nov. 10, contains a short article on this subject by Mr. Brooks.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO. AT THE WORLD'S FAIR.

Elec. World. N.Y. H.F. BUTCHER

Among the many and varied scenic effects produced at the World's Columbian Exposition there was probably none which more impressed the observer or was more universally admired than the Court of Honor electrically lighted The lagoons fringed with innumerable lights. the



AN INTERESTING SECTION OF MACHINERY HALL.

buildings with their cornices aglow and, most picturesque, the great dome of the Administration Building outlined by incandescent lamps, all combined to produce a picture which has probably never been equaled, and which cannot be reproduced in either its novelty or uniqueness.

It will probably be remembered that when the contract for lighting the World's Fair was awarded to the Westinghouse Electric and Manufacturing Company, its competitors were very pronounced in the expression of their opinion as to the ability of the Westinghouse company to carry out its contract, especially in the face of the decision of the long contested lamp suit which was rendered about that time. The successful performance of the contract, and the artistic illumination of the Court of Honor, as well as the incandescent lighting of the grounds and buildings of the Exposition, have been so satisfactorily carried out that an illustration and description, not only of the machinery and apparatus of the great plant furnishing the light, but also of the instructive electric exhibits made by the Westinghouse Electric and Manufacturing Company, have been deemed of interest.

To carry out the contract which had been secured only after long continued and keen competition, the Westinghouse company installed in Machinery Hall a complete alternating current central station equipment. This station was by far the largest plant in existence, and illustrated on a very large scale the high degree of excellence to which alternating current machinery, adapted to power purposes as well as to arc and incandescent lighting, has been brought by this company. The plant was located adjacent to the south wall of Machinery Hall and about the centre of the building, occupying a space of some 31,000 square feet. The general arrangement of the apparatus is shown in the accompanying ground plan illustration.

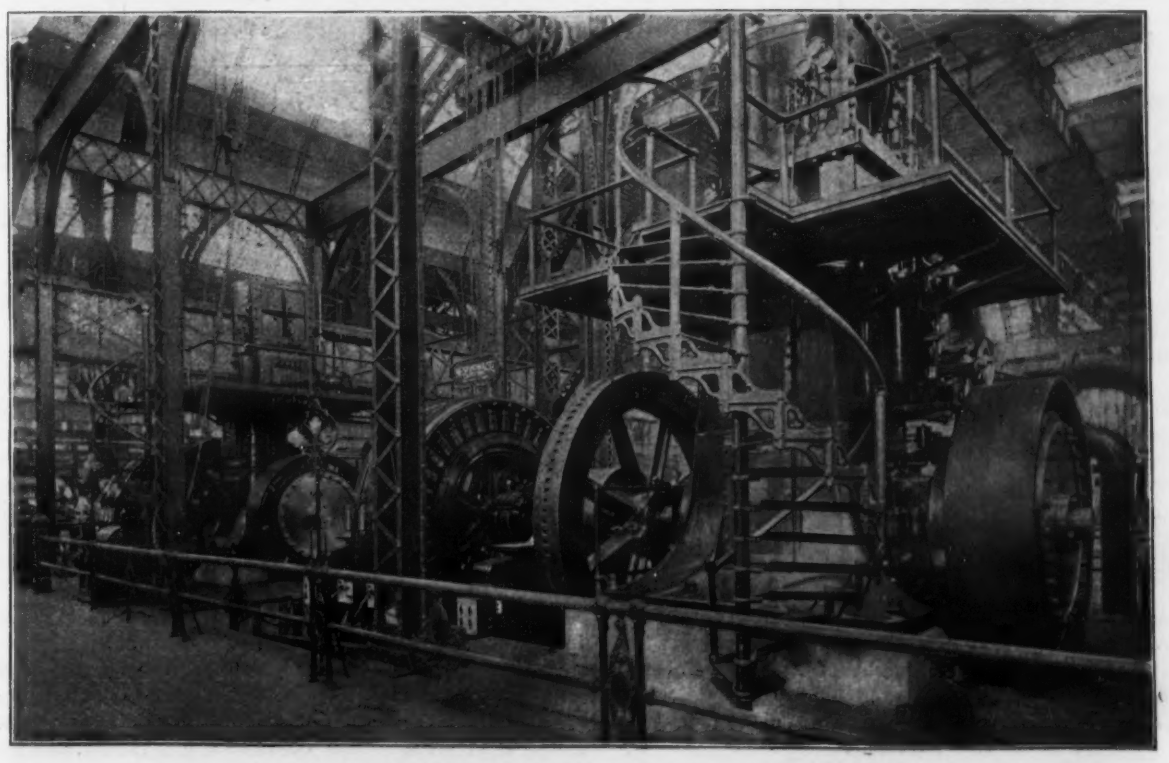
The installation comprised the following apparatus: Two 750-kw. two phase alternators, belt driven by a 3,000-h. p. quadruple expansion engine built by the E. P. Allis Company, Milwaukee, Wis.; one 750-kw. two-phase alternator, belt driven by a 1,000-h. p Fraser & Chalmers engine of the Corliss type; one 750-kw. two-phase alternator, belt driven by a 1,000 h. p. McIntosh & Seymour engine; one 750-kw. two-phase alternator, belt driven by a 1,000-h. p. Buckeye engine; one 750-kw. two-phase alternator, belt driven by a 1,000-h. p. Atlas engine; six 750-kw. two-phase alternators, each driven direct by a 1,000-h. p. Westinghouse Columbian steeple engine; two 240-kw. single-phase alternators, each belt driven by a 350-h. p. Westinghouse compound engine; three 75-kw. exciters each driven direct by a Westinghouse 100-h. p. comound engine; a complete marble switchboard for 12 two-phase alternators, 2 single-phase alternators, 4 exciters and 40 circuits.

The total output of the plant was 9,480 kw. The records of readings of the current and potential, which were taken at the switchboard every half hour from the time the Exposition was thrown open to the public, showed that about 55 watts at the generator terminals were required for each 16-c. p lamp connected to the circuit. The station, therefore, was capable of simultaneously supplying about 172,000 16-c. p. lamps.

The accompanying plan indicates the location of each engine, alternator, exciter and the switchboard. Alternators numbered 1, 2, 6, 7, 8 and 9 were direct driven by Westinghouse engines. Nos. 3, 4, 5 and 10 were respectively belt driven by Buckeye, Atlas Corliss, McIntosh & Seymour, and Fraser & Chalmers engines, while machines numbered 11 and 12 were driven by tandem belts from the 3,000-h. p. engine of the E. P. Allis Company. Alternators numbered 13 and 14 were 240-kw., high speed, standard single-phase machines, belt driven by Westinghouse engines. The Kodak exciters, direct coupled to 100-h. p. Westinghouse engines, are shown at *A*, *B* and *C*, while the plan view of the feeder and dynamo switchboard will be noted in the space adjacent to the Fraser & Chalmers engine and alternator No. 10. All of the engines and dynamos were erected upon massive foundations, installed under the supervision of the mechanical engineers of the Exposition. In the case of alternators Nos. 6, 7, 8 and 9, with their engines, a single concrete foundation was used.

The plant illustrated on a very large scale the methods of driving by direct coupling of engine shaft to the dynamo shaft, and by the use of belting. The two alternators belted to the large Allis engine—the engine started by President Cleveland when he opened the Exposition—were tandem driven by belts 72 inches in width; the distance from the centre of the engine shaft to the centre of the shaft of its nearest dynamo was 47 feet; that to the centre of the more distant dynamo, 65 feet. To foreign engineers, who are unaccustomed to our high grade belting, these large and fine quality belts, furnished by the Page Belting Company, of Concord, N. H., proved to be an extremely interesting feature of the installation.

The advantage of the direct connected over a belt driven machine, as regards the saving in floor space, is well illustrated by a comparison of the space occupied by one of the 1,000-h. p. "engine-dynamos," as they are called, consisting of a 1,000-h. p. Westinghouse Columbian steeple engine and a 750-kw. alternator, with that occupied by belted engines and alternators. The outside measurement of the direct connected unit was 31 feet 8½ inches by 13 feet. The space occupied by the smallest belt connected engine and alternator was greatly in excess of this, being about 65 feet by 27 feet.



LARGE DIRECT CONNECTED ENGINES AND DYNAMOS.

THE DYNAMOS.

Each alternator, electrically considered, is a double machine which delivers to its circuits two-phase currents, the difference between the phases being almost exactly 90 degrees. The frequency is 60 periods per second, or 7,200 alternations per minute, and the potential at the terminals of the machine varies from 2,000 volts to about 2,300 volts, depending upon the load, drop in primary circuits and transformers, secondary wire, and upon the potential required by the lamps. The speeds of the alternators, both belt driven and direct connected, are 200 revolutions per minute. Each machine has two armatures which are mounted upon the same shaft and are magnetized by two fields electrically and mechanically independent of each other.

This construction is shown in the double page illustration, in the centre of which a direct connected alternator and Westinghouse engine will be noticed, while the belt driven machine is illustrated at the top.

The fields are of the circular or ring type, having 36 inwardly projecting poles built up of mild steel, laminated, and cast solid into the yoke. Lathe-wound coils are slipped upon the poles and securely fastened in position by bolts. The armatures are of the toothed type, generally employed by the Westinghouse company for alternating current work. The armature coils are lathe-wound and any one of them may be readily removed and replaced without disturbing the other coils upon the same armature. Each armature has 36 teeth, to correspond with the same number of poles on each field. The armature shafts are of forged steel, in self-aligning ball bearings, equipped with automatic oilers. The armature shaft carries at each end, between the armatures and bearings, two ring collectors which serve to receive the alternating current from each armature. The shaft also carries two commutators from which a rectified current is conveyed to the auxiliary winding of the field coils. The excitation of the field is chiefly derived from separate exciters, hereinafter described, but the auxiliary excitation is employed to secure automatic increase of the magnetic field proportioned to the reaction due to the currents flowing in the armature.

THE SWITCHBOARD.

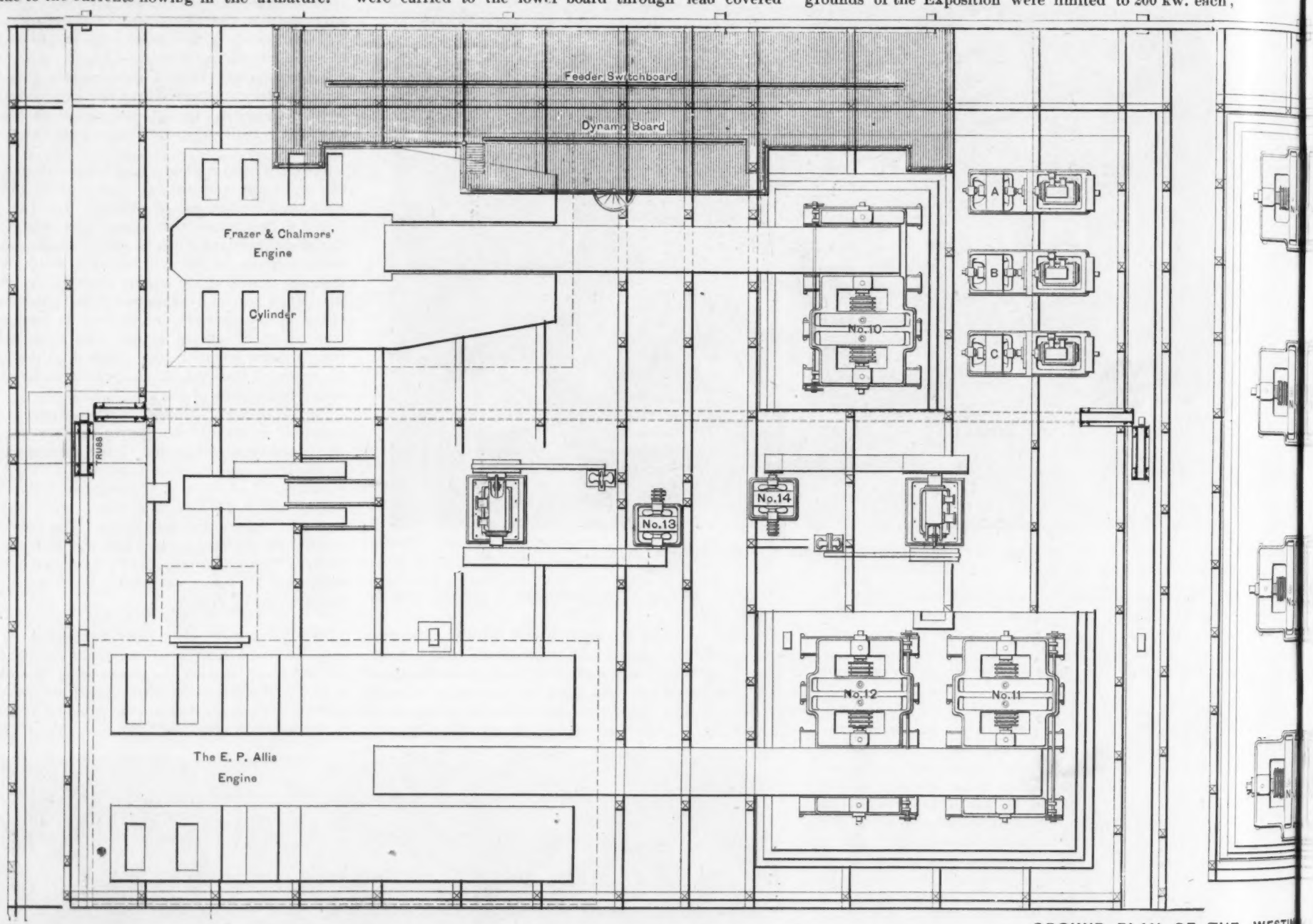
A switchboard was erected upon a double gallery against the south wall of Machinery Hall. This board has been fully described in The Electrical World of May 20, 1893, but a general résumé will not be out of place here. The floor of the first gallery was about 10 feet above the level of the space occupied by the engines and alternators, while the floor of the second gallery was 8 feet higher. The board was made up of marble panels, which were supported by an iron framework, consisting of angle iron supported upon floor beams of the galleries, and securely braced. The uniform width of all panels was 20 inches. The panels, most of which, themselves, constituted the bases upon which the instruments were mounted, extended into the framework of angle iron and were secured by bolts and vertical metal strips. These nickel plated strips were of semi-circular section, and extended from the floor line to the top of each board, covering the abutting edges of the marble panels, and assisting to hold the panels in position. A narrow frieze of marble was carried along the top of each board, and a vertical strip 5 inches wide at each end served as a decorative finish.

The board on the lower gallery was the dynamo and exciter board; that on the upper gallery was the supply circuit or feeder board. The circuits from the alternators were carried to the lower board through lead covered for the connection of the supply circuit to any of the 14 alternators. Each circuit was protected from lightning by the Wurts non-arcing arrester.

The specifications under which the contract was awarded made it necessary to provide for supplying any circuit from any alternator, and inasmuch as the two-phase type of dynamo was selected, it became necessary to design a board which would permit any one of several hundred combinations to be made. The generating plant was equivalent to 26 single-phase machines, and provision was made for supplying each of the 40 distributing circuits from any one of these 26 sources; at the same time the arrangement was such that mistakes were impossible and the wiring of the board symmetrical and comparatively simple.

The panels were each lighted by etched lamps suspended from goosenecks from the top of the board, and in addition to these, four highly ornamental arc lamps, of the constant potential, alternating current type, were hung from arching wrought iron posts at the ends of the boards. Access to the lower board was secured by an artistic spiral stairway of iron. The upper platform was reached by means of two stairways from the lower gallery. Handsome ornamental railing of wrought iron inclosed the front and ends of both galleries.

The operation of this board proved satisfactory in the highest degree. The distributing circuits throughout the grounds of the Exposition were limited to 200 kw. each,



GROUND PLAN OF THE WESTIN

The current for the auxiliary excitation is derived from small transformers carried in the spider of the armature. The main current of the armature traverses the primary of the transformers, while the secondary current of the transformers is rectified by the commutators. In this manner the automatic compounding of the field is attained without the introduction of high potential current into the field coils.

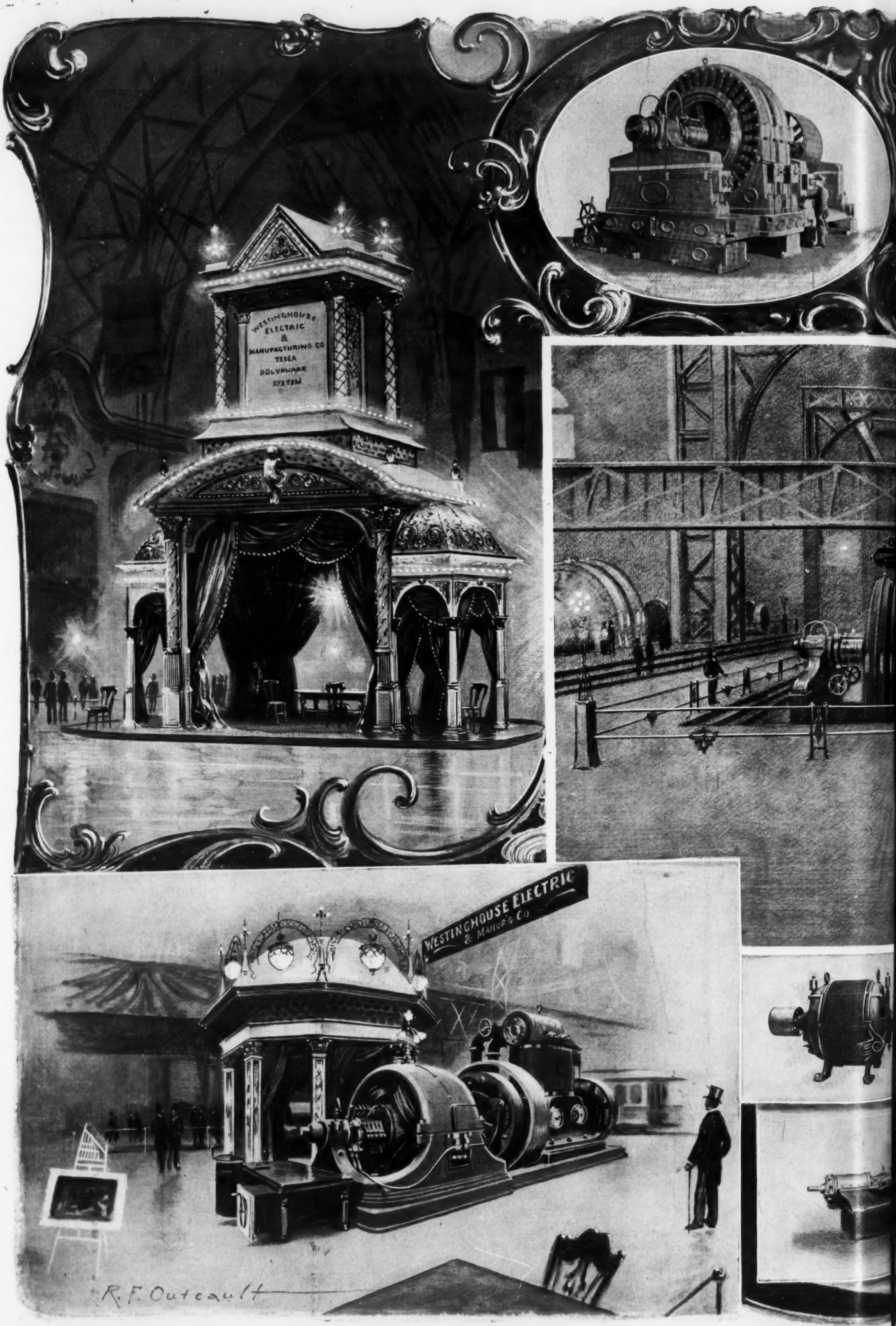
In the belt driven machines provision was made for adjustment of the belt by sliding the machine as a whole upon foundation rails. The connection between the Westinghouse engines and their alternators was made by a rigid coupling. The size of the alternators is well shown in the illustrations; they stood 15 feet 1 inch in height from the top to the foundation. The weight of a machine of the belt driven type was a little over 140,000 pounds, while that of a direct connected alternator was 106,000 pounds.

THE EXCITERS.

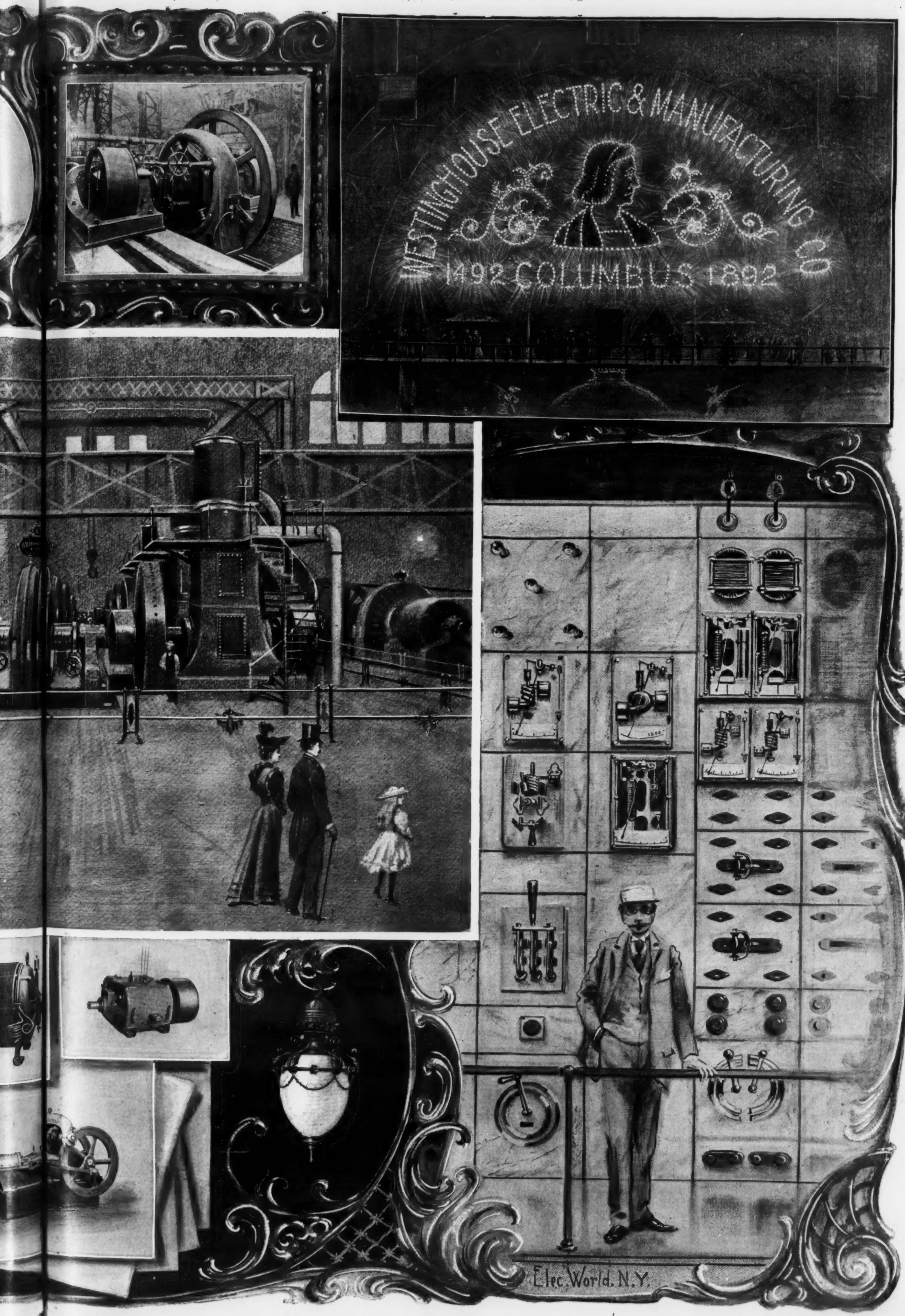
Current for exciting the fields of the alternators was obtained from three 75-kw. continuous current machines, of multipolar type, direct driven by Westinghouse automatic engines. These exciters made 300 revolutions per minute, and delivered current at 250 volts. Two of them furnished current to excite 10 alternators, and the third was held in reserve. At the close of the Exposition, one of these machines had been running continuously for about three months, and in that time made over 37,000,000 revolutions.

cables, and thence through switching devices to the upper board. Instruments for measuring the current and potential of each set of the two phase alternators and of the two single-phase machines were provided on 13 panels, one panel being allotted to each of the 12 double machines, and the thirteenth panel being provided for the two single-phase machines. Provision was made for quickly substituting a relay or reserve dynamo for any one of those in operation. Two-way switches were used for each dynamo circuit, and the terminals at one end of these switches were always kept charged by the reserve alternator, so that by simply throwing the switch of the machine which was in difficulty, or which for any reason it was desired to shut down, the load was easily and instantly transferred from any alternator to the reserve machine. The board was so arranged as to make it impossible for a careless attendant to accidentally throw two alternators together. Multiple arcing the machines was considered inadvisable, and the board was so designed as to make this practically impossible. Four panels were provided in the lower board for exciters and the fifth for instruments measuring the combined output of the exciters when in multiple. One of these panels was not in use, as three exciters proved ample for the number of machines required.

The upper board comprised 40 panels and provided for a like number of supply circuits. Each panel contained a switchboard converter, a compensator, voltmeter, ammeter, Stillwell regulator, switch, fuses and plug receptacles and it is worthy of note that a board capable of distributing five or even ten times as much energy—that is to say 40,000 or 80,000 kw.—embodying the sectional features of this board, can be constructed to occupy practically the same space. This board, which was probably the largest ever constructed, measured in the upper gallery 71 feet in length and 9 feet 6½ inches in height. The lower part was 32 feet 6 inches long, and 11 feet 3½ inches high. The claims made by the Westinghouse company for this most interesting piece of electrical apparatus are as follows: 1. Safety against fire risk, being built entirely of non-combustible material. 2. Safety as against possible injury to attendants, as no high tension circuit or terminal is exposed on the front of the board, hence contact with dangerous circuits is impossible. 3. Safety as against accidental connection of two alternators, secured by the arrangement of the board itself. 4. Flexibility, in that any machine can be made to supply any circuit or set of circuits. 5. Capability of extension; the sectional construction adopted renders it easy to extend the board to accommodate additional machines without materially changing the wiring. 6. Sectional construction; the entire face of the board being built up of small units, transportation and erection are facilitated. 7. Accessibility, as all the wires are exposed and terminals readily accessible back of the board. 8. Uniformity and simplicity. Though there is a large amount of wiring on the board, the panels are alike and hence uniformity and simplicity are secured.



Some Striking Features of One of t[illegible]



incipal Exhibits at the World's Fair.

THE LAMPS.

It is a noteworthy fact that for all the incandescent lighting at the Exposition the new Sawyer-Man stopper lamp was used. Burned out lamps were periodically returned to the factory in Pittsburgh and there taken apart and supplied with new carbon burners and returned to be again used. The lighting of the Exposition has therefore afforded the Westinghouse company an excellent opportunity to test the value of the two-part lamp, of which the globe, stopper and leading-in wires can be used over and over again. The percentage broken in shipment was very small, and the success of this form of construction was claimed to have been demonstrated.

Above the gallery covering the entire eastern wall of the Electricity Building, the Westinghouse company made a very handsome exhibit by the use of the new stopper lamp. The photograph in the upper right-hand corner of the large illustration reproduces the design, but cannot accurately portray the beautiful effects produced by the various colored lamps.

EXHIBIT OF STREET RAILWAY APPARATUS.

In preparing the exhibit of street railway apparatus, and indeed in all of its exhibits in the Electricity Building, the Westinghouse company adopted the policy of selecting only apparatus illustrating new and valuable features. Duplication of exhibits was avoided wherever practicable. Therefore the railway exhibit was not as extensive as it might have been made, but it clearly illustrated the methods used by the Westinghouse company in the construction of railway generators and motors, and the method of mounting motors upon car trucks. The principal exhibit was located in Section H, Space 1, just south of the centre of Electricity Building and north of the exhibit of the Bell Telephone Company. The apparatus shown comprised one 270-h. p. generator direct driven by a Westinghouse automatic compound engine, to which it was connected by a flexible coupling, constituting what is known as the "Westinghouse Kodak Outfit." This arrangement is extremely compact and substantial. A general view of the space containing railway apparatus is shown in the lower left hand corner of the double page illustration. Beyond the handsome octagonal pavilion shown in the centre of the space was located a 400-h. p. multipolar railway generator, of the belt driven type. Several armatures such as are employed in these generators were exhibited, and were specially noteworthy for the simplicity and mechanical excellence of their construction. The fields are composed of four pole pieces, projecting radially inward from a circular yoke. The pole pieces are built up of hundreds of plates of sheet steel manufactured to a certain formula adopted by the Westinghouse company, which it is claimed secures magnetic qualities superior to anything hitherto obtained. The plates are pressed tightly together and secured by iron rods riveted to cast-iron end plates. The pole pieces thus constructed are then cast into the yoke, or field ring, which is of high grade cast iron. A distinctive feature of these generators as compared with others of corresponding size is the use of the single casting constituting the lower half of the field and the supports for the bearings; a construction which secures great rigidity of form. We have already said the armatures shown were examples of high class mechanical design and workmanship. The conductors pass through insulating tubes placed in slots about the periphery of the armature core. These insulating tubes are threaded through from one end of the armature core to the other, the slot in the core being of such a form that it is impossible to slide the tube out of place radially. It is thus impossible for the conductors and tubes to be thrown out by centrifugal force, and no band wires are required to hold them in place, as they are absolutely secured by the iron core.

The Westinghouse street railway motors of the single reduction type were fully exhibited. They were shown complete on trucks, dismounted, and with their fields thrown back. An extremely valuable characteristic of the Westinghouse motors resulting from the multipolar construction and method of armature winding employed, lies in the fact that the proper distribution of current in the armature conductors does not depend upon the uniformity of magnetization of the pole pieces, nor in the clearance of the armature, as measured from different poles of the field. If the bearings become worn and the armature is consequently decentralized, there results no unbalancing of the work which the armature conductors are called upon to perform. These points were well illustrated by the rotation of the armature of a motor which had the upper half of its field thrown back and only the lower half magnetized. The armature rotated at any desired speed, being controlled by the rheostat in its circuit, without sparking at the brushes and without abnormal heating of the armature conductors.

Complete lines of switches, ammeters, voltmeters, circuit breakers, both hand and automatic, lightning arresters of the Keystone and Tank type, as well as the smaller details, such as trolley wheels, fuse boxes, brushes, etc., were all fully shown.

A Three Rivers truck, built by the Sheffield Velocipede Car Company, of Three Rivers, Mich., was fully equipped with two 25 h. p. motors, controllers, diverter, etc., and shown in operation. A handsome 20-foot "accelerator" car of the Brownell company, St. Louis, Mo., was shown, equipped with two 30-h. p. motors, series multiple controllers, etc. The John Stephenson Company, Limited, loaned an 18 foot car with the new Tackaberry truck, which the Westinghouse company also electrically equipped and furnished with a glass floor, which allowed satisfactory inspection of the motors in operation, the car being raised from the track.

In addition to the exhibits of railway apparatus in Electricity Building, the Lamokin Car Works, of Chester, Pa., had an 18-foot car equipped with two 30-h. p. Westinghouse motors of the single reduction type shown in the Transportation Building, Section L-N, Spaces 9 to 11, and on the outside exhibition track, near the north end of the Terminal station, was a 20 foot car of the Laclede Car Company, St. Louis, Mo., completely equipped with Westinghouse apparatus.

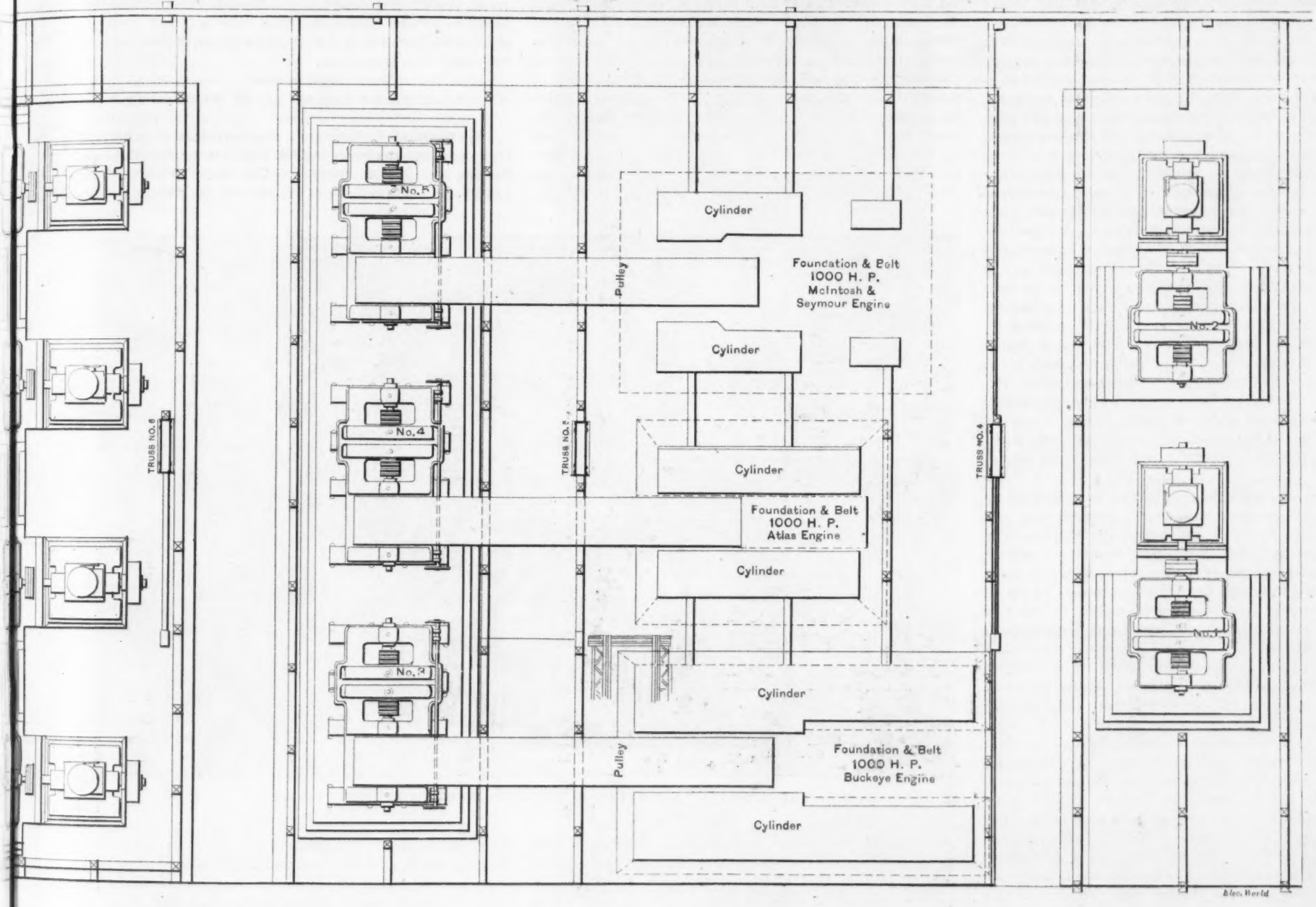
In Machinery Hall a 600-h. p. six pole railway generator, of the direct connected type, was in operation, supplying current for the power circuits of the Exposition. The armature of the generator was carried on the shaft of a Corliss compound engine, which operated at the extremely low speed of 90 revolutions per minute. The construction of this machine was massive in a noteworthy degree. As an illustration of this it may be mentioned that the radial depth of the commutator bars was four inches. The field poles were of mild steel, and the armature winding similar to that of the multipolar generators in Electricity Building.

Some idea of the size of this machine can be gained from our reproduction in the upper part of the large illustration. The generator rested in a pit in order that the armature shaft might be on a proper level for the engine. A very heavy flywheel served to maintain the momentum of the armature. The six sets of brushes were so connected that three of them supplied current to one terminal and the other three to the other terminal. The brushes were all controlled by a single holder that was operated by a handwheel. In connection with this generator was a complete marble switchboard, equipped for one generator and four supply circuits.

The Westinghouse Electric and Manufacturing Company did not deem it necessary to make an exhibition of railway motors in service, inasmuch as their apparatus is exclusively used by the South Chicago Street Railway Company and the Chicago City Railway Company. Upon these two roads there were daily carried thousands of passengers to and from the Exposition. The Chicago City Railway Company very kindly offered the judges on the National Commission the opportunity of carrying out tests with the apparatus on these cars, which the Westinghouse company very much desired them to do, but on account of scarcity of funds appropriated for testing purposes the judges were unable to make what would have been a very interesting and valuable test.

EXHIBIT OF POWER TRANSMISSION APPARATUS.

In Section J, Space 2, north of the centre of Electricity Building, and south of the French section, the Westinghouse Electric and Manufacturing Company showed in operation the most extensive plant of the Tesla polyphase type which has been erected up to the present time, either for exhibition purposes or for practical work. The question has frequently been asked, "Why cannot the electric companies show any polyphase plants in practical operation?" and the Westinghouse company here showed its



USE EXHIBIT AT WORLD'S FAIR.

faith in its apparatus constructed under Tesla patents by building and installing an operative plant on a very large scale.

The centre of the space was occupied by a handsome gilt pavilion, shown in the upper left hand corner of the large illustration. This booth served at once for ornament, advertisement and office; chairs and tables being provided for visitors and representatives of the company.

The power for operating the machinery was obtained from the lighting circuits supplied by the Westinghouse plant in Machinery Hall. Two-phase currents from this source were employed to operate two Tesla motors, one a 500-h. p. machine, which took the place of the turbine or engine which would be used in practical operation to drive the generator, the other a 5-h. p. motor, direct connected to a small continuous current machine, which furnished the field excitation for the generator. Neither of the Tesla motors were intended to constitute a part of the exhibit proper, but served to furnish the power necessary for the plant, and proved that the two-phase alternating current of 60 periods per second, supplied by the large installation in Machinery Hall, was adapted, not only to supplying incandescent lamps and arc lights, but also to the operation of motors.

The transmission exhibit proper consisted of a complete generating station north of the pavilion, an overhead transmission circuit, and a receiving and distributing station south of the pavilion. The apparatus in the generating station comprised one 500-h. p. two-phase alternating current generator; one 5-h. p. direct current exciter; marble switchboard, with instruments, and raising or step-up transformers, which received alternating current at a potential of 400 volts from the generator and delivered current at 1,200 volts to the transmission circuit. The generator was a six-pole machine making 600 revolutions per minute, the frequency employed being 30 periods per second, or 3,600 alternations per minute. The machines were of the multipolar type and similar in general appearance to the railway generators manufactured by this company, except that in addition to the commutator there were four collecting rings provided, which were carried upon the opposite end of the shaft. The machine as here used served simply as a generator of alternating current, but the construction permitted its being used as a rotary transformer, as a direct current generator, or as a motor operated by either direct or alternating current. The step-up transformers were located behind the switchboard, and, as before noted, they delivered current to the transmission circuit at a potential of about 1,200 volts. In practical transmission over very great distances much higher potentials would, of course, be employed, but it was not considered advisable to introduce extremely high voltages in an exhibit.

The line was carried to the pole located near the step up transformers, and thence to another pole located near the switchboard of the receiving and distributing station. The wires were supported upon special glass insulators designed by the Westinghouse company. No oil was used in these insulators, which were similar to those in successful use in transmitting energy from the power station in the San Antonio Canyon to the city of San Bernardino in south California, a distance of 28 miles. The step-down transformers were located behind the switchboard in the receiving and distributing station south of the pavilion, where the potential was reduced to 400 volts. The switchboard, like that in the generating station north of the pavilion, was non-combustible, consisting of marble panels on which the switches and instruments were mounted. These panels were fitted into skeleton frames of angle iron, similar to the big switchboard in Machinery Hall. All terminals charged with high potential were behind the board, and only accessible to the attendant, who, in order to reach them, had first to unlock a door and go behind the board; it was impossible from the front of the board to receive a discharge shock by contact with any part of an instrument or switch.

From the distributing switchboard in the receiving and distributing station, alternating current was conveyed to the 500-h. p. rotary transformer, a 60-h. p. motor of the two phase synchronous type, and a 60-h. p. rotary transformer delivering direct current at a potential of about 50 volts, intended for electrolytic purposes.

The 500-h. p. rotary transformer, like the generator north of the pavilion, was provided with a commutator at one end, and a four ring collector on the other end of the shaft. Alternating current was supplied to the armature through the collectors, and continuous current was delivered from the commutator, and used to operate a Dorner & Dutton railway truck equipped with two 30-h. p. single reduction motors. Direct current from the same source was also employed to drive a 60-h. p. direct current motor mounted upon an 18-inch Ingersoll-Sergeant air compressor, shown at the bottom of the large illustration; and also to supply direct current arc lamps of the constant potential type, arranged in sets of nine across the 500-volt circuit. The rotary transformer was also used as a motor, and by means of belts was made to drive a Worthington pump and an alternating current arc light machine.

The power transmission proper, it will be noted, did not include the 500-h. p. motor which was used to drive the generator, nor the 5-h. p. motor which was directly connected to the exciter in the generating station. It began properly with the two-phase generator, which was driven by a motor supplied with current from the lighting circuit, and it was identical in every respect save one with the system which has been adopted by the Cataract Construction Company for its large installation at Niagara Falls. The one difference between the two is the frequency employed, which, instead of being 30 periods, has been reduced to 25 periods per second.

EXHIBIT OF ARC AND INCANDESCENT LIGHTING APPARATUS.

In Spaces 1 and 2, Section B, Electricity Building, were shown very complete lines of Westinghouse lightning arresters, switches, ammeters, voltmeters and transformers, both complete and dismounted, illustrating very clearly the method of construction. The new features shown in this exhibit of particular interest were the non-arcing metal lightning arresters introduced into converters, the new Sawyer-Man stopper lamp in various processes of manufacture, and converters in the various stages of construction, showing clearly the method of building up the iron, and the use of entirely separate and thoroughly insulated primary and secondary coils.

As the machines used for lighting purposes were to be seen in actual operation in the large plant in Machinery Hall, the company did not make any extensive exhibit of such machinery in Electricity Building: but here was shown a standard 450-kw. alternator field casting which very clearly illustrated the Westinghouse method of casting laminated poles into a cast iron frame. There were also shown, complete, two of the smaller alternators, viz., of 40-kw. and 60-kw. capacity, and one 25 light alternating arc machine. Supported in backets, to permit thorough inspection, the Westinghouse toothed armatures were exhibited, both complete and partially dismounted, disclosing very clearly the advantages and simplicity of this method of armature winding. The direct current lighting apparatus was well represented by various sizes of the letter type and Horizontal type machines. The Manchester motor, which seems to be commanding considerable attention and commendation for use with cranes, was shown complete and dismounted. A 60-h. p. multipolar generator of low voltage and very large current was no the least attractive of the exhibits in this space. One curiosity shown in this exhibit, probably overlooked by many on account of its size, was a small dynamo and steam engine. The dynamo stood $\frac{5}{16}$ inch in height, and yet was so perfect in every detail as to be capable of operation. The engine matched the dynamo, and was run by compressed air.

EXHIBIT OF TESLA APPARATUS AND HIGH POTENTIAL, HIGH FREQUENCY PHENOMENA.

In one corner of Space B-1 was erected a room, perhaps 30-feet square, in which were daily shown experiments illustrating the remarkable results obtained by Mr. Tesla by the use of high frequency high potential currents. Current was taken from the lighting circuits connected with the plant in Machinery Hall, and transformed up to perhaps 1,000,000 volts by oil transformers situated back of the room. The rate of alternation was increased from 7,200 alternations per minute to about 400,000 per second by the use of condensers and an arc breaking device. Within the room were suspended two hard rubber plates covered with tinfoil; these were about 15 feet apart and served as terminals of the wires leading from the transformers. When the current was turned on, the condition in the vicinity of the plates was made such as to render luminous vacuum bulbs which had no wires connected to them, but lay on a table between the plates, or which might be held in the hand in almost any part of the room. These were the same experiments and same apparatus shown by Mr. Tesla in London about two years ago, where they produced so much wonder and astonishment.

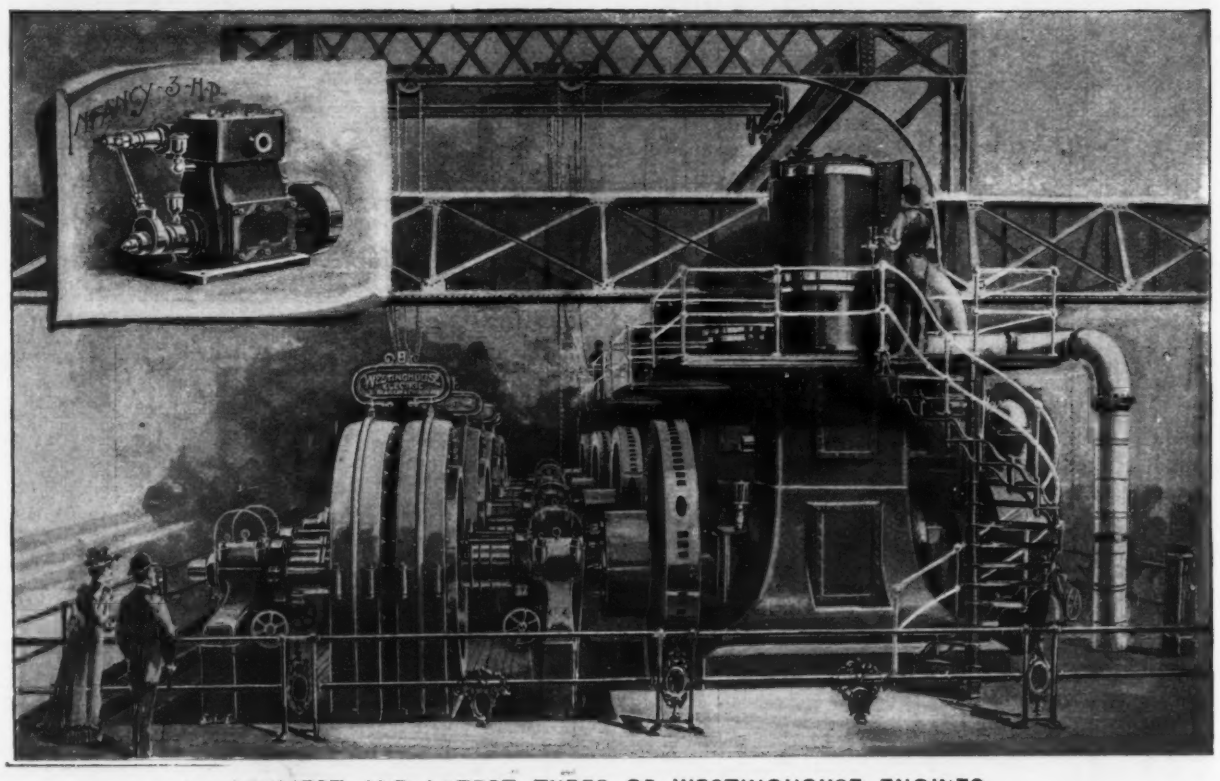
Over the entrance to this room was a glass sign bearing in its centre the name "Westinghouse." Current of high potential was led from one transformer terminal to the letters by means of invisible wires; the other terminal was connected to tinfoil on the back of the glass plate. When current was turned on the electricity would discharge across the surface of the plate, and over its edge to the tinfoil on the back, producing the effect of a modified lightning discharge, and accompanied by a similar deafening noise. This was probably one of the most novel and interesting attractions in a sensational way seen in the building, as the noise could be heard several hundred feet away, and the miniature lightning flash was very brilliant and startling.

Outside of the booth was exhibited a collection of the various forms of motors and other apparatus employed by Mr. Tesla in the discovery and development of his polyphase system. Here were to be seen also the oscillators, the subject of a lecture by Mr. Tesla before the American Institute of Electrical Engineers at the World's Fair, in August last, which attracted so much scientific interest. On a table was a Tesla ring which illustrated the principle of the rotary magnetic field. The ring consisted of an iron core wrapped with two coils of wire, through which a two-phase current was passed. The effect produced upon metallic bodies placed within the influence of this field was practically the same as though a magnet were rapidly carried along the axes of the coils.

Altogether, from a scientific as well as a popular standpoint, the Westinghouse Electric Manufacturing Company made an exhibit which was not only a great credit to themselves, but was one of the most interesting features of the Columbian Exposition.

Westinghouse Engines at the World's Fair.

The exhibit of Westinghouse engines attracted much attention among engineers and the public in general, through its size and varied character. The main exhibit of six 1,000-h. p. engines, direct connected to Westinghouse alternating current dynamos, was the most noticeable feature, but in addition to this there were eight of smaller sizes, making in all 14 engines, aggregating 7,695 h. p., being by far the largest exhibit of this kind ever made at any exposition. The accompanying cut illustrates the development of 12 years of practice in this line, the small figure being the first engine constructed and the large one an excellent view of the row of four engines which place 4,000 h. p. developed and utilized within a smaller space than has ever before been attempted on land. The other two engines of 1,000 h. p. were in an adjacent block, similarly connected to dynamos of the same pattern. The history of the construction of these six engines indicates the constructive development which a shop can reach, for they were built from new designs and patterns within four months—in fact seven were built in this time—without losing a casting or spoiling a part. The seventh engine was provided to insure against delay through possible accident in shipment or erection, and upon the successful starting of the six engines at Chicago, the seventh was sold to the Missouri Electric Light Company, of St. Louis, where it is now in operation. This type, while a departure from the regular Westinghouse pattern, involves most of the salient features which have become so well known, and contains various new ones, especially the pneumatic inertia balance which relieves the governor of all weight and inertia of valve parts, and which by the simple turn of a valve is immediately transformed into a steam starting gear. It is believed that this type of compound engine will come into favor rapidly where large units are required, as it combines a high steam efficiency with various approved features of the Westinghouse design. A fact not generally known, but of some interest regarding the operation of these



EARLIEST AND LATEST TYPES OF WESTINGHOUSE ENGINES.

engines, is their relation to the practical service of the Exposition lighting, for, while many lights were carried by other engines on exhibit, operating during Exposition hours, the Westinghouse engines carried lights not only during the regular hours, but all night, Sundays and various odd hours, thus rendering more extended service than is usual in the operation of exhibits.

The two 400-h. p. compound engines of the regular Westinghouse type, in operation in the central block, between the two large Corliss engines, were sold to the Exposition, and will continue to operate through such time as lighting is required. These engines were the first placed in operation last year, furnishing power for incandescent lights previous to the starting of the main exhibits. In the Electricity Building a 270-h. p. Kodak outfit of the regular type, shown in the small cut, was operated in a rather novel way. It being inconvenient to obtain steam in that location, the generator was operated as a motor, driving the engine, the latter being piped to give all the appearance of running under steam. It was difficult to perceive that it was not operated in the usual way, although a few of the more curious would investigate and easily ascertain the facts. This outfit was sold to the Lehigh Traction Company, of Hazleton, Pa.

A somewhat obscurely located though interesting and fine running set of engines were the three 125-h. p. Westinghouse compounds direct connected to three small Westinghouse multipolar dynamos, operating as exciters for the large alternating current machines. These were kept in practically continuous operation, and on Aug. 8 the engineers in charge started the one nearest the aisle for a run which should be absolutely continuous throughout the rest of the Exposition. It was operated for 85 consecutive days and nights, making in that time over 35,000,000 revolutions, and when shut down at the close of the Fair was running with perfect smoothness. Engines of this type have frequently been operated throughout longer periods, but this, so far as known, is the longest run ever made by any engine in a public place. A neighboring blackboard on which hourly records of time and revolutions were kept attracted much attention. Two Standard engines of 125 h. p. each were loaned to the Chicago Paper Trade Club to operate its paper making exhibit, and were sold to the Boone Street Railway Company, of Boone, Ia.

The display of steam engines generally at the Exposition was, on the whole, highly creditable and representative, but no exhibit was more characteristic of the product and magnitude of the interests represented than the above.

Two Interesting Displays at the Fair.

EXHIBIT OF THE EDISON MANUFACTURING COMPANY.

The Edison Manufacturing Company, 110 East Twenty-third street, New York, made an attractive exhibit of their wares at the southwest corner of the gallery floor. The display adjoined that of the Phonograph Company to the east, and seemed at first glance to be a part of it, as the inclosure was after the same design as that of the other company.

Within this space, distributed over a pyramidal-shaped stand, were displayed cases of the celebrated Edison-Lalande battery intended for phonograph, fan motor, electro-medical and other uses. These contained anywhere from one or two to six or more cells, and of capacities ranging from 15 ampere hours to 900. As is well known, the Edison Lalande cell differs widely from other open circuit cells, in that it maintains its electromotive force practically constant throughout its life. The elements employed are zinc and black oxide of copper, and the electrolyte is a 25 per cent. solution of caustic potash. To prevent the absorption of carbonic acid from the air by the latter, it is covered with a heavy paraffine oil, through which the electrodes extend.

The phonograph case usually contains four cells and the fan-motor cases three. A number of Edison ironclad fan motors were shown in operation.

A handsome medical combination cabinet, equipped with the Kennelly milleampere, was also displayed in operation. A dental outfit with eight cells and a reversible motor, together with dental tools, lights and cauteries, and numerous medical batteries, went to complete this interesting exhibit of Edison-Lalande batteries and their applications in the arts and sciences.

EXHIBIT OF THE NORWICH INSULATED WIRE COMPANY.

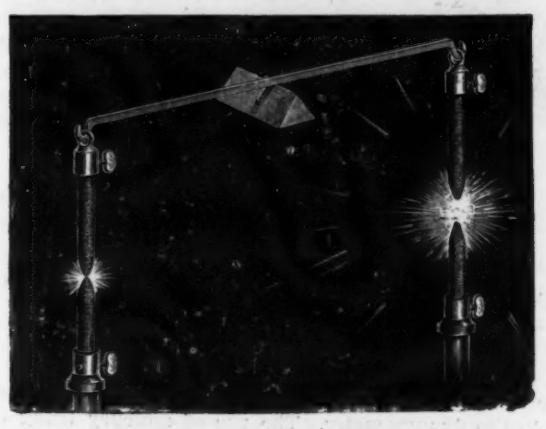
The Norwich Insulated Wire Company, of 44 Broad street, New York City, had a very tasteful display of its insulating materials, wires and cables near the centre of the east gallery. The raised dais upon which the display was placed was fenced in in front by a neat bronze railing and on the other sides by a fence whose uprights were pine posts and whose rails were various sizes of stranded lead covered electric light cables. These all showed the paper insulation which this company has been using so long and which has become so generally adopted on account of its high insulating properties. The largest cable exhibited was two inches in diameter of stranded copper, paper insulated and lead covered. From this all sizes were shown down to No. 5 or 6 solid. Back of this fence of cables, and showing them in relief, the space consigned to this company was draped with handsome chenille curtains.

In the centre of the space and near the aisle was a large table upon which were shown specimens of electric light cable and of large telephone and telegraph cables insulated with paper, both dry and paraffined. Two pyramids of insulating paper and insulating tape were shown, and back of these, neatly arranged on shelves, were samples of smaller sizes of insulated wires. On either side of the table were two pyramids of reels of cables and insulated wire, the bottom wire in each case being lead covered, followed by a reel of unsheathed insulated wire, and these alternating to the top, the light-colored lead and black insulation making a pleasing contrast with each other. There were also displayed within this space much larger reels of lead covered electric light wire, the whole making an attractive and creditable display.

The See-Sawing of Arc Lamps.

BY GEORGE CUTTER.

Where arc lamps are run two in series on incandescent circuits much annoyance has been caused by their interfering with each other's regulation, the result being an alternate feeding and separating of the carbons, which has been termed "see-sawing." For those who do not wish to go into the theory of this action, the simple analogy illustrated by the accompanying illustration may be interesting. It will be remembered



SEE-SAWING OF ARC LAMPS.

that all lamps of this class have the feeding mechanism controlled by two magnets, one being on the main circuit and in series with the arc itself, while the other is a shunt around the arc. Then, as the carbons burn away and the arc lengthens, the comparative resistance of the two paths for the current changes and allows the lamp to feed the carbon. In the case of series lamps, the main current is kept practically constant by the dynamo or its regulator, and the voltage at the lamp varies. But with a pair of lamps on a constant potential circuit the sum of the voltages remains unchanged, so that the increased consumption at one lamp will rob the voltage from the other, and vice versa. In other words, the left-hand arc in the cut will have very little counter electromotive force, so that most of the voltage will be left for the other one, and will draw the right-hand pair of carbons far apart. But this action exaggerates the difference in voltage still more, until the left-hand arc touches its carbon and then separates. In this way one pair of carbons will approach while the others are separating, the action being just as if they had a mechanical lever suspension, as pictured. I hold this matter of see-sawing to be one of the greatest problems met in adapting arc lamps to incandescent circuits, but I think it is well met by the peculiar design of the Waterhouse lamps, and it is said that users bear out this statement. At any rate, the pictured analogy is interesting as showing a drawback which has at last been overcome.

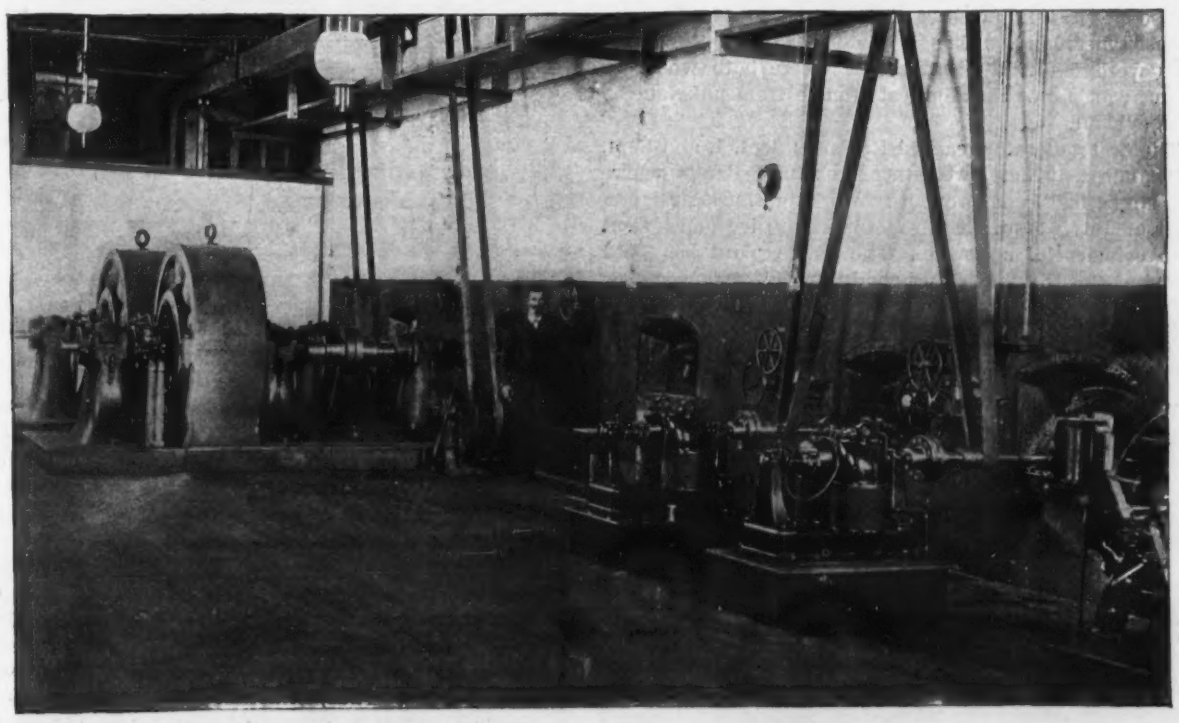
The First Three-Phase Transmission Plant in the United States.

The first water power in Southern California to be utilized for the distribution of power, as well as lights, is that situated at the mouth of Mill Creek Canon, nine miles from the city of Redlands, one of the most flourishing of the younger cities of the State. Less than two years ago a few of the public spirited citizens of Redlands saw the chance of utilizing the fine Mill Creek power and organized a company, and the enterprise was rapidly pushed forward and about nine months ago a contract was closed with the General Electric Company for the necessary apparatus.

Mill Creek is a fine and unusually reliable mountain stream that springs from the slopes of mountains San Bernardino and Grayback, the two loftiest of the Sierra Madre range. The main body of the stream and a convenient intake were found near the mouth of the canyon and, by a comparatively small deflecting dam of masonry 40 feet long and head works it was possible to turn the water into a tunnel 160 feet in length, cut through the rock, and thence into a heavy steel pipe line, which was brought down the stream a distance of 7,250 feet, where was obtained a convenient site for a power house. At the end of the tunnel is a sand box 75 feet long by 25 feet wide to catch any sediment before the water can enter the pipe line. At this point the fall is in the neighborhood of 353 feet, giving exactly 160 pounds pressure to the square inch in the receiver that terminates the pipe line, which can deliver 2,400 cubic feet of water per minute.

The power house is for the most part an excavation not far from the bank of the creek. The roof is erected on very low side walls and under the lean-to, on the right, is the wheel pit with the receiver and Pelton wheels. The wheel shafts extend through iron shutters, set in windows in a massive rubble retaining wall that bounds the wheel pit into the dynamo room, where they are directly coupled to several machines. This dynamo room contains the following apparatus, as may be seen from the cut, which gives an excellent view of its interior: Two 250-kw. ten-pole three-phase generators delivering current directly to the lines at 2,500 volts between lines; two D-10 exciters, each capable of energizing the fields of both generators, and one 50-light, 2,000-c. p., Thomson-Houston arc dynamo. With the stream at its lowest 800 h. p. is developed at the generators. Room is left and foundations are in place for a third three-phase generator and a second similar arc machine. The large generators run at 600 revolutions, give 6,000 alternations per minute, and have a rated output of 100 amperes at 2,500 volts. The general arrangement of the station was planned before the contract for the apparatus was let (and in fact, before the character of the machinery was determined) substantially according to the designs of the late A. W. Decker, whose recent death was a serious loss to the electrical interest of the Pacific Coast.

To each of these large machines just mentioned a



INTERIOR OF THREE-PHASE TRANSMISSION PLANT.

Pelton wheel is directly coupled, the three-phase generators being supplied with 200-h. p. double wheels, each operated by a double nozzle.

The regulation of the hydraulic power is by the ordinary differential nozzle operated by Pelton differential governors driven from one of the exciter shafts. A second small differential governor, driven from the other exciter shaft, steadies the action of the first by regulating the exciter wheels. The water having done its work is discharged into a ditch and utilized for irrigation purposes.

On the side of the dynamo room opposite the dynamos are located the switchboards. The chief interest of these lies in the three-phase switchboard for the two big

generators. This is elaborately devised to meet every condition or combination that it might be desired to make with the two machines, and the two circuits that run from the power house. Either machine can be thrown on either circuit and both machines in parallel on either or both circuits. At present the parallel connection is chiefly used in shifting over the load to obtain perfect continuity of service. A six-ton traveling crane permits ready handling of any of the machinery.

The interior of the station is a model of its kind. Particularly to be noted are the excellent foundations, and a result is an excellent alignment of shafts, the large generators running without even a tremor at the bearings.

From the power house are run two three-phase circuits, each composed of three 00 B. & S. wires. One of these runs to the company's office at Redlands, a distance of seven and a half miles, and from thence is distributed over the city for lighting and power purposes. On a substantially built pole line the other extends to Mentone, four and a half miles, where is located the artificial ice plant of the Union Ice Company.

In this plant is installed a self-starting 150-kw., triphase, 750-revolution, 6,000-alternation synchronous motor, belted through the medium of a countershaft to two large compressors for the ammonia, a circulating pump for the compressor jackets, a force pump to supply water for the ice, and a small elevator for handling the ice. In order to ascertain the point of synchronism, a Thomson acoustic synchronizer is employed, and gives unqualified success. The ice plant is of the so-called "pipe" type, and the freezing room and condenser contain nearly 20 miles of three-quarter inch iron pipe, in testing which the motor was stopped and started at short intervals for several weeks. The operation of the ice plant is continuous, the load being on the motor 24 hours a day, and, barring accidents, 365 days a year, The motor plant at this point is likely soon to be increased to keep up with an increase in the plant.

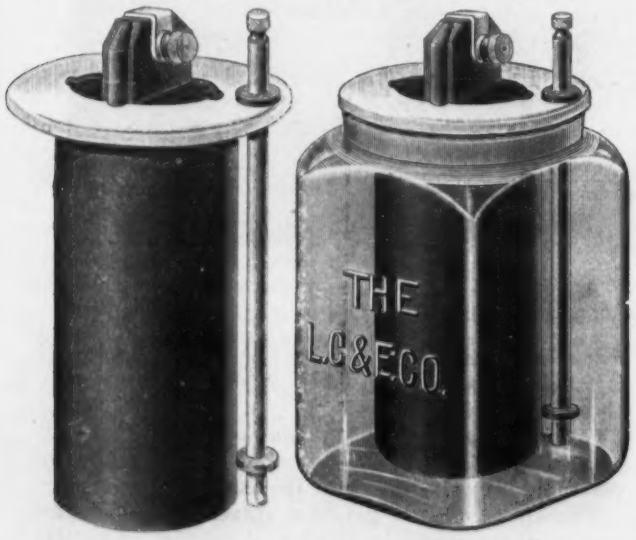
From the main Redlands circuit a number of lines are taken off from the ice plant and also for the neighboring town of Mentone. There are now in operation 30 arc lamps, besides over 1,000 16-c. p. incandescent lamps distributed over three legs of the circuit. A number of small induction motors without commutators or collecting rings are to be installed before the beginning of next year, to meet the demand already created by the success of the plant. The transformers are very similar to the ordinary General Electric type of transformer, except that they are designed for 50 cycles per second, and to reduce the pressure from 2,200 to 110 volts. So far as possible rather large transformers are used with comparatively long secondaries. These are used only directly at the point where light and power are delivered.

No trouble whatever has been experienced from any unbalancing of the lighting lines. In fact, shortly after the plant was started up the largest single block of lighting in the city, wired for three circuits, had these circuits worked for several nights on two legs of the triphase generators pending the setting up of the third transformer; and, although the lights from these two legs were set in adjacent rooms where both would be seen at once, not the slightest trouble from unbalancing was evident.

The first generator reached Redlands Sept. 1, and Sept. 7 incandescent lamps were turned on in Redlands, where arc lamps had been previously working since the latter part of July. Sept. 13 the motor at the ice plant went into commercial operation. The whole plant has been running steadily and doing good service ever since.

The Improved Laclede Battery.

We illustrate a new voltaic cell known as the improved Laclede battery, which has just been placed on



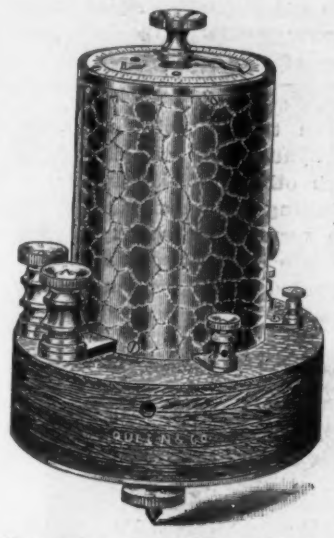
Improved Primary Battery.

the market by the Laclede Carbon and Electric Company, formerly of Peru, Ind., but now located at Kokomo, Ind.

The inventor, Mr. P. C. Burns, claims that this latest form is far superior to the old style of cylinder battery. Mr. Burns, who is superintendent of the company, is also the inventor of the microphone battery, as well as of the old styles of the Laclede and Hercules batteries.

Non-Inductive Wattmeter for Direct Currents.

The wattmeter shown in the figure, made by Queen & Co., Philadelphia, is constructed on the inclosed dynamometer principle. The case is of brass mounted on a wooden base built up of a number of sections to prevent warping. The extra resistance, about 3,000 ohms for a 110-volt circuit, is wound non-inductively, and in sections on wooden spools placed inside the base, which is suitably ventilated. Within the case, half of which may be easily removed, are to be found both the fixed and movable coils, the latter coil consisting of from 100 to 200 turns, depending on the range desired, of No. 34 copper wire wound on a light mica form. This coil is suspended from a rigid support by means of a fine phosphor bronze strip 1½ inches long, a spring being provided at the bottom for the return current. Suitable guides and a clamping device are provided, the former to prevent the coil from being used when slightly out of centre, due to improper leveling. A spiral spring attached to the torsion head serves as the control. The upper end of the pointer attached to the system plays over the zero of the scale, the same as in the dynamometer. The use of mercury being entirely avoided renders the instrument perfectly portable, and the employment of a large amount of extra resistance along with the delicately constructed and suspended system reduces to a minimum the power consumed by the wattmeter itself, and at the same time leaves it quick to respond to any change in the power being measured. In order that the instrument may be applicable throughout a wide range of current, two pairs of fixed or current coils are provided, the one pair consisting of 10 turns each, with a carrying capacity of 25 amperes, and the other of one turn each with a carrying capacity of 250 amperes placed on over the other coils. Thus, either 25 or 200 amperes may be made to effect a complete revolution of the torsion head. The potential circuit may be made applicable to the higher voltages by the mere insertion of more extra resistance.



Non-Inductive Wattmeter.

Condensers for Electric Light Plants.

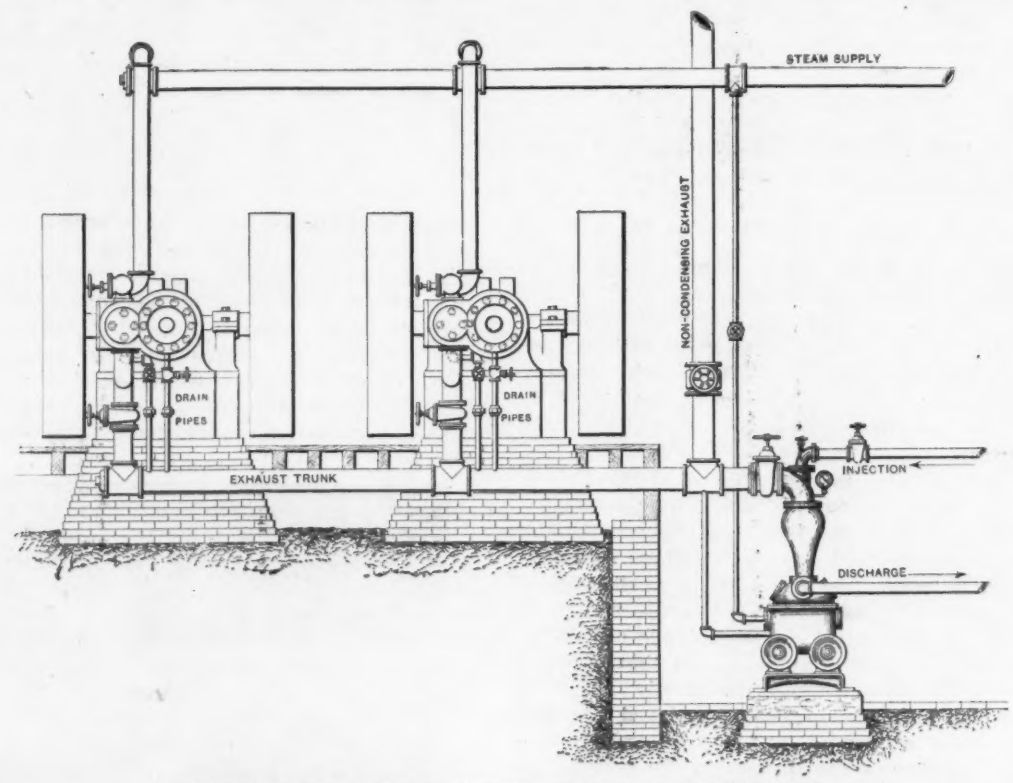
A large number of steam engines in electric lighting plants are situated so that an adequate supply of water can easily be had for condensation, but are at the present time non-condensing, laboring under a back pressure of 14.7 pounds due to exhausting against the atmosphere.

The value of a vacuum to an engine under normal conditions is at a low estimate equal to 25 per cent. of the power developed by the engine running non-condensing. This means that, by the use of a condenser, the coal consumption can be reduced one-quarter to one-fifth with the same production of light, or the number of lights may be increased a fifth without burning more fuel.

With electric light and power companies, the cost of fuel is the great expense. The cost of the light is dependent primarily upon the cost of the coal, and any increased economy of the boilers or engines, improved belt transmission or dynamo efficiency directly affects the profits in nearly like proportions. It is obvious that the gain of 25 per cent. made available by the condenser is of greater importance to electric light companies than to cotton or flour mill operators, where the money paid for coal is of small value compared with that received for the product.

Upon changing an engine from non-condensing to condensing it is found that the boiler pressure in many cases may be lowered 15 to 20 pounds with nearly as high results. Doing this often lengthens the life of the boilers considerably, and is very desirable to such as have had long service. When steam plants are located near dwellings, the noise of escaping exhaust steam is sometimes found to be annoying. This objectionable feature may be entirely relieved by the application of a condenser. Several engines may be exhausted into one condenser, and a vacuum maintained on all or part of them at a time.

The exhaust pipes from the engines lead to an exhaust trunk to which the condenser is attached. When an engine is stopped, it is shut off from the exhaust trunk by a gate valve in its exhaust pipe. In large plants it is well to divide the engines into groups, and use two or more condensers, putting those engines which have about the same time of running in the same group. At stations where the water supply is distant, inexpensive means can often be devised whereby the water can be reached. An excellent method is to lay a conduit, connecting the water supply with a well in the vicinity of the engines. From this well the water is readily taken by the condenser if the lift is under 20 feet. Where the lift is greater, it is practical to lower the condenser by placing it in a pit. A cheap and serviceable conduit can be constructed of sewer pipe laid level, and at such a depth that a flow of water into the well is assured. The quantity of water needed to properly condense the exhaust steam depends, of course, on its temperature. It may be stated that one and one-quarter to two gallons of water per minute are required for every horse power developed by the engine. The use of city water supply for condensation is not recommended, unless the cost is so low as to be merely nominal.



STEAM PLANT USING WORTHINGTON CONDENSERS.

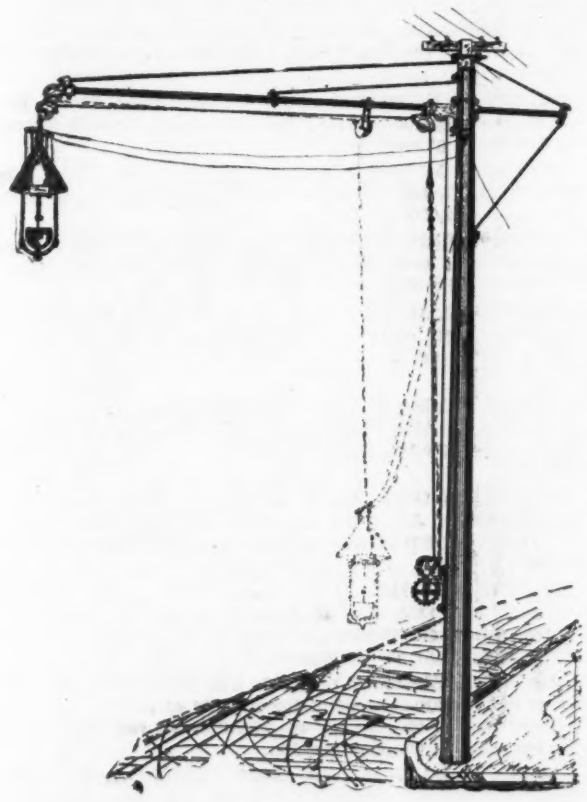
The accompanying illustration is taken from an electric light steam plant, consisting of two high-speed engines of well known build, upon which a vacuum is maintained by a Worthington condenser, manufactured by Henry R. Worthington, 86 Liberty street, New York. The condenser is located below the level of the engine room floor, to bring the lift of the injection water within the prescribed limit of 20 feet. The exhaust trunk is laid below the flooring, and the whole arrangement presents a compact and neat appearance. It will be noticed that the injection valve and the small globe valve supplying live steam to the condenser pump, are quite conveniently placed, being near together and easily reached by the engineer from the engine room floor. The cylinder cocks of each engine are piped separately into the exhaust trunk, and the steam chest drain pipes have also independent entrance into the exhaust trunk. The condenser is shown exhausting into the trunk, and consequently a vacuum is maintained on its cylinders also. It is obvious, however, that all that has been said about heaters and feed water above is perfectly applicable to this case.

An Arc Mast Arm.

The accompanying illustration represents a new and convenient device, manufactured by J. J. Renehan, New Britain, Conn., for hanging electric arc lamps over the centre of the streets, thereby quite effectively distributing the light, and enabling the lamp to be suspended over the trolley wires and still be brought to the base of the pole for trimming.

The arm shown is specially designed to enable the lamp to be raised and lowered for attention and repair without interfering with overhead trolley wires of street railway systems, and without being hampered by or hampering surface traffic. It will be noticed that the lamp takes an angular path moving substantially in line with the mast arm and mast, making a sharp change of direction when it arrives at or near the point of their intersection. Thus, to lower the lamp for trimming or any other attention it may need the geared pulleys are turned, imparting a movement to the detachable sectional endless band in such a way as to bring the lamp toward the pole. When the lamp nears the intersection of pole and arm, the hook acts as a stop, and the shaft is then shifted to the drum. The galvanized wire rope is attached to the drum at one end, and at the other end of the rope is a hook. The hook is then snapped on to one of the links of the detachable endless band, and the drum turned slightly so as to free the band from the hook resting on the pulley frame. The drum rope is now lengthened by the section of the band and the lamp is raised and lowered at will. It is a quick and steady motion, each revolution of the crank imparting a movement to the lamp of over 16 inches.

The construction of this arm has been well considered. Placing the whole weight of arm directly on top of pole often tends to weaken it, and the line wires remain unprovided for. These arms are trussed at the side as well as at the top, rendering them very strong. If the crank slips from the manipulator's grip the lamp will not smash against the pole, and if desired it can be left suspended at any point between the pole and the end of



ARC MAST ARM.

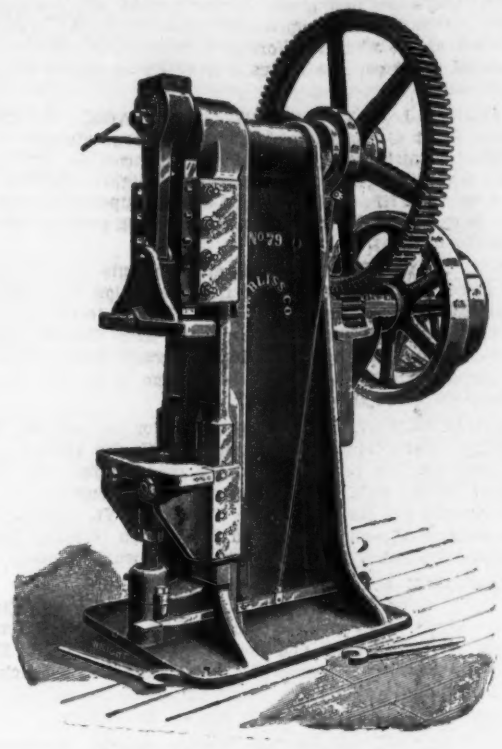
the arm. The drop of the lamp is not controlled by the length of arm, as in other mast arms, as there is sufficient wire rope attached to the drum to lower it within reach of the manipulator. Therefore no stepladder is required.

The Cummings & Engelman Conduit.

In The Electrical World of Nov. 25 it was stated that the Cummings & Engelman Conduit Company had secured the contract for the Niagara Falls Power Company for the exclusive use of its conduits for transmitting power from the Falls to a neighboring point. We are informed by Mr. J. F. Cummings, president of the Cummings & Engelman Conduit Company, ...at this is not strictly correct, as the contract haa not yet been secured, although negotiations are being made for it.

Improved Power Press.

The accompanying cut shows a long-stroke press recently designed by the E. W. Bliss Company, 12 Adams street, Brooklyn, N. Y., for redrawing, shaping, trimming and other operations on deep sheet metal articles. It is provided with a screw adjustment for the table, which permits the use of dies varying greatly in height, and also has an eccentric device in the pitman which facilitates making the finer adjustments required for the tools. The press is provided with an automatic clutch controlled by foot-power so as to have the slide stop automatically at the top of stroke, unless continuous strokes are wanted, in which case the foot is kept on the treadle. The ma-



LONG STROKE POWER PRESS.

chine is made with or without gearing. For broaching castings or forgings, where a very slow movement is required, it is frequently constructed with back gearing of much greater ratio than shown, in which case a friction clutch on the driving shaft is used, instead of automatic clutch on the crank shaft. The press as shown in the cut weighs about 8,200 pounds, has a maximum distance between bed and slide of 15½ inches, and adjustment for this space of 10 inches and a stroke up to 8 inches. The ratio of gearing is 1 to 7½, and the number of strokes usually made per minute 40.

The Death of Anthony Reckenzaun.

On Saturday, Nov. 11, Mr. Anthony Reckenzaun died at Stockwell, England. The cause of his death was consumption, and while he had been in ill health for some time the end came suddenly and unexpectedly.

The name of Anthony Reckenzaun is not only well known in England, but is a familiar one in the United States, where he had taken part in the practical development of electricity.

He was born at Gratz, Austria, in 1850, and was therefore at his death only 43 years of age. He remained in his native land for the first 22 years of his life and received there a thorough technical education as well as considerable experience in engineering construction. In 1872 he went to England, where he obtained employment with Messrs. Ravenhill & Miller, a large engineering firm, with whom he remained for a number of years. After visiting the Paris Exposition in 1878 he concluded to devote himself to the study of electrical engineering, and attended Prof. Ayrton's lectures at the Finsbury Technical College. In 1881 he became associated with the Faure Accumulator Company, which he left soon afterward to accept the position of engineer of the Electrical Power Storage Company; there he designed the first electric launch, "Electricity," driven by E. P. S. storage batteries, in 1882, and afterward constructed an electric street railway car, which was exhibited on the West Metropolitan Tramway in 1883. In 1885 Mr. Reckenzaun started in business on his own account for the purpose of building boats, cars and electric motors for various purposes. The "Volta" was perhaps the best known of his launches, and in 1886 made a trip betwen Calais and Dover and later between Dover and London.

Mr. Reckenzaun spent nearly a year in this country, where he introduced his system of traction, and also did some work in the line of building electric launches. He returned to England from a visit to this country shortly before his death. He was especially interested in secondary batteries, and did valuable work in this field. He delivered numerous lectures on storage batteries, electric traction, etc., before various scientific societies, both abroad and in this country. The Society of Arts awarded him its silver medal for his paper on "Electric Locomotion," and the Institution of Electrical Engineers awarded him the Paris Exposition premium medal in 1892 for his paper on "Load Diagrams and the Cost of Electric Traction." His treatise on "Electric Traction on Railways and Tramways" is well known in this country. He was vice-president of the Old Students' Association of City and Guilds of London Institution, a member of the Institution of Electrical Engineers, of the Society of Arts, American Institute of Electrical Engineers and the Vienna Electro-Technical Society.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Nov. 25, 1893.

GENERAL ELECTRIC, if it is to be judged by the quantity of the gossip concerning it, is the most active stock in the whole stock market. The rumors regarding the finances of the company which the persistent selling has revived, are those that have been repeated from time to time for several months, only this time they are repeated in more virulent form than ever. The company disposed of the story that its finances were in such tangled shape as not to permit of its paying the interest due Dec. 1 on the debenture bonds by advertising that the interest would be paid. Failing in this direction, the bear clique assert that their statements about the straitened condition of the company will be proved charge, but insiders say the question presents no difficulty. The financial condition of the company, to judge from statements apparently officially inspired, is not so bad. The floating debt, excepting so far as indorsed notes of other companies and individuals are concerned, is settled. Moreover, the company has not transferred to the new Securities Trust all of its assets. It is said to still possess all its Brooklyn Illuminating and some other stocks. The strange part of the whole proceeding has been the indifference with which Drexel, Morgan & Co., who, excepting the Ames estate, are more deeply interested than any one else in General Electric stock, view the continued decline. A writer in the Philadelphia "Press" publishes a story that is given as an explanation of this lack of support. The story reads that Mr. J. Pierpont Morgan had to shell out some $2,000,000 when he joined the combination to support the stock around 70, and that he thereupon made a new resolution, expressed by him with some emphasis: "Henceforth I shall never spend a dollar to maintain the price of a security upon the Stock Exchange or to put the price to any figure. I have done with that forever. I shall attend to banking business and shall stand under no security." That is why Drexel, Morgan & Co. don't support General Electric. It is stated that the business of the company has fallen off a third, but to make up for this all the business is done on a cash basis, all orders necessitating any credit being refused. At present about 2,000 men are employed at Lynn five days a week, and about 1,500 at Schenectady. The company is working as economically as possible, and will do so until business conditions improve more than they have.

THE WESTINGHOUSE ELECTRIC PEOPLE are about to take some aggressive steps that must result in great and lasting benefits. It will be remembered that, when the World's Fair was closed an ordinance was introduced into the Chicago City Council to buy the big electric light plant of the Westinghouse company that supplied the lights for Jackson Park. The city soon found that such a scheme was impracticable, and, although the price asked, $1,500,000, was little in view of the capacity of the installation, the offer of the Westinghouse company was reluctantly refused. The Westinghouse company, and President George Westinghouse himself is given as authority for the statement, will now bring their huge World's Fair plant to this city. It will be transferred to the United States Electric Lighting Company, a local offshoot of the Westinghouse company.

WESTERN UNION TELEGRAPH STOCK has been strong the greater part of the week. Brokers for insiders have been the most conspicuous buyers and a good deal of stock has been taken by investment houses. These latter purchases are made for the account of small investors who are attracted by the large surplus account of the company and its uninterrupted record of dividend payments. The buying, in Wall street criticism, is "very good," and this means much for a continuance of strength. The stock has all week been very scarce in the loan market, and the alarm of the bear crowd at this state of affairs has had something to do with the firmness of the quotation.

THE EDISON ILLUMINATING COMPANY, as stated in these columns last Saturday, voted this week to issue an additional lot of $1,750,000 five per cent. under the previous mortgage, dated March 14, 1890. The total vote cast at the special meeting of stockholders, held on Monday, to authorize the directors to make the issue was 51,000 shares. The proceeds of the bonds will be used entirely for construction. A syndicate has already purchased $1,000,000 of the new issue at par, and has an option on the remainder ,$750,000, at the same price. (The old bonds are selling 104 bid.) The total outstanding bonded debt is now $3,562,000, including the $1,000.000 already placed. Brooklyn Edison Electric Illuminating stock has appreciated considerably during the week. As stated in these columns, the recent political change in Brooklyn will benefit the security, and this, with the good business showing of the company, has made a demand for the stock. Very little is in the market, however, and that is now bid at 96, a gain of six points over a week ago. It is confidently thought by the brokers that the stock will soon be bought for above par, a figure which the stock brought before the financial depression.

THE ERIE TELEGRAPH AND TELEPHONE COMPANY'S dividend No. 40 has been mailed to 1,557 stockholders, a gain of 63 since the last dividend. The dividend amounts to $48,000. The Erie properties have paid in dividends $1,931,481.

THE AMERICAN BELL TELEPHONE COMPANY reports that its output in the month ending Nov. 20 decreased 2,755 instruments. The number returned increased 2,545, so that the net loss for the month is 5,300 instruments. The stock holds strong, however.

THE EDISON COMPANY, of Chicago, as was related last week, will not have its business cut into by a rival corporation. Acting Mayor Swift has vetoed the ordinance creating the Mutual Electric Company.

ELECTRICAL STOCKS, NOV. 27, 1893.

	Par.	Bid.	Asked.
Brush Ill., New York	50	20	40
Detroit Electrical Works	10	2	3
Cleveland General Electric Co	..	85	90
East River Electric Light	100	..	65
Electric Con. & Supply Co. pref.	15	15	16
" " " " " com	15	15	17½
Edison Electric Ill., New York	100	97	98
" " " 1sts	...	104	105
Edison Electric Ill., Brooklyn	100	96	106
" " " Boston	100	115	124
" " " Chicago	100	220	230
" " " Philadelphia	100	120	125
Edison Electric Light of Europe	..	2½	5
" Bonds	..	80	85
" Ore Milling	..	5	12
Fort Wayne Electric	..	4½	6
General Electric Company	100	38⅛	38¼
" " deb. 5's	..	78	80
Interior Conduit and Ins. Co	100	25	35
Mount Morris Electric	..	..	65
Westinghouse Consolidated	50	25	26½
" " pfd	50	41	43
Western Union Telegraph	..	90⅝	90¼

AFFAIRS OF THE COMPANIES.

THE NATIONAL ELECTRIC COMPANY.—The sale of the National Electric plant by Receiver Rust to Peter Truax for $7,500 has been confirmed by the Court. Five Chicago concerns, A. L. Ide & Sons, the Ansonia Electric Company, the Knapp Electrical Works, the Standard Electric Company and the Chicago Stamping Machine Company protested by attorneys against the confirmation, and A. L. Ide & Sons offered to give $12,000 for the plant, alleging as a reason why they did not bid at the sale that they had received an erroneous impression from conversation with the receiver and newspaper publications that the court would not confirm a sale for less than $50,000. The court held that these reasons were not substantial. The attorney for the receiver asked the court for an order restraining the Chicago creditors who filed their claims here under the receivership from going on with suits instituted in Chicago against the National Electric. Arguments on this motion are to be heard Dec. 11.

THE CATARACT GENERAL ELECTRIC COMPANIES, whose incorporation we noted several weeks ago, has taken general offices at 120 Broadway, New York, and elected the following officials: President, William Mertons, 50 Wall street; vice-president, Frank W. Hawley, 120 Broadway; secretary and treasurer, Charlton T. Lewis, 32 Nassau street. The company has secured the exclusive right for the distribution of electric power from Niagara outside of Niagara and Erie counties. Four subsidiary companies have been organized at Rochester, Utica, Syracuse and Albany under the names of the Cataract Electric Company, of Rochester, etc. It is the intention to have a trunk electric line from Niagara to Albany, and from which current will be supplied to the four cities named and to other cities and towns along the route; another of the objects of the company is to supply current to canal boats on the Erie Canal. The recent trial of electric canal propulsion near Rochester was under the direction of Mr. Frank W. Hawley, vice-president of the company. None of the electrical and engineering details involved in this extensive transmission project has, we learn, been yet worked out.

NEW INCORPORATIONS.

THE HOME INDUSTRIAL ASSOCIATION, Port Angeles, Wash., capital stock $50,000, has been formed to operate electric light and power plants, etc., etc. G. V. Smith, J. F. Smith, T. Jarvis, J. E. Beam and E. E. Beaumont. Port Angeles, Wash., are the promoters.

THE MIDWAY ELECTRIC LIGHT COMPANY, St. Paul, Minn., capital stock $30,000, has been formed to generate and supply electricity for light, heat and power purposes. The incorporators are: G. B. Lynch, E. A. Forbes and G. E. Downing, St. Paul, Minn.

THE ANDERSON ELECTRIC LIGHT COMPANY, Anderson, Ind., capital stock $50,000, has been formed to construct, maintain and operate an electric light, power and heat plant. The organizers are C. L. Henry, J. F. Wild, E. E. Hendee, L. M. Cox and S. Metcalf.

THE GLOBE ELECTRIC LIGHT COMPANY, Portland, Me., capital stock $300,000, has been formed to manufacture and deal in all kinds of lamps for electrical and other uses. R. Berrenberg, C. Bartels and J. P. Spang, all of Boston, Mass., are the incorporators.

THE CARBONDALE & FOREST CITY PASSENGER RAILWAY COMPANY, Carbondale, Pa., capital stock $150,000, has been formed to construct and operate an electric railway in Lackawanna county. The organizers are J. W. Aitken, Edwin Corey and J. M. Nicol.

THE VILLISCA ELECTRICAL COMPANY, Villisca, Ia., capital stock $25,000, has been formed to erect and operate an electric light and power plant at Villisca, Ia. M. N. McNaughton, W. S. Alger, H. C. Stoddard and B. F. Fast, all of Villisca, are the interested parties.

THE PARSONS ELECTRIC LIGHT COMPANY, Parsons, W. Va., maximum capital stock $100,000, has been incorporated to furnish electric light, heat and power to towns, corporations and individuals, etc. T. B. Gould, J. P. Harford and J. S. Dougal, of Parsons, W. Va., are the promoters.

THE BOARDMAN RIVER ELECTRIC LIGHT AND POWER COMPANY, Travers City, Mich., capital stock $100,000, has been formed to manufacture and supply electricity for light, heat and power. L. K. Gibbs, Mayfield; J. S. Hodges and J. L. Gibbs, Traverse City, Mich., are interested.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Nov. 27, 1893.

MR. CHARLES E. CHAPIN has taken the New York agency for the new Spencer trolley wheel, and the first sample was received during the week.

THE BROOKLYN TRACTION COMPANY and the Long Island Traction Company have entered into negotiations with a view to consolidation.

MR. CHARLES E. BIBBER, of the Consolidated Electric Manufacturing Company, Boston, was in New York during the week to close an important contract for the company.

THE EDISON ILLUMINATING COMPANY of Brooklyn asks that the subway laws be enforced, as otherwise it cannot compete for city lighting with favored companies having overhead lines.

MR. F. A. SCHEFFLER, 74 Cortlandt street, has received the following telegram: "Withdraw all tenders World's Fair boilers. Have disposed of entire lot. The Stirling Company." This refers to the 2,800-h. p. of Stirling boilers on exhibition at the Fair.

MR. HENRY B. OAKMAN, the well known electrical contractor of 136 Liberty street, received the order to install a plant for the Gould Car Coupler Company, calling for 18 arcs and a number of incandescents, and is now actively pushing the work.

MR. A. W. FIELD, vice-president of the Peckham Motor Truck and Wheel Company, has returned from a seven-weeks' trip in the West, and is about to go into New England. Mr. Field took one order for 25 trucks, and a number of smaller orders, amounting to sufficient to make the trip a very satisfactory one.

AN ELECTRIC FOUNTAIN FOR CENTRAL PARK.—The General Electric Company has written to the park board suggesting that one of the electric fountains used at the World's Fair be brought to New York City and placed in Central or some other city park. The secretary was instructed to ascertain the cost.

MR. GEO. L. COLGATE, of 136 Liberty street, has taken the sole agency for the sale of the product of the Standard Molding Works. These are new goods on the market, and are made in all the standard sizes required by contractors. A large stock is carried at 115 and 117 Worcester street, and quick delivery is assured. This concern makes a specialty of hard wood moldings to order.

ELECTRIC LIGHTS FOR CENTRAL PARK.—The Edison Electric Light Company, which has been requested to extend its subways into Central Park, has announced its inability to make such extension at present, and the lighting of the park drives by electricity will be indefinitely postponed unless provision is made for the putting in of a lighting plant of its own by the department.

MR. A. DE CASTRO is making arrangements to go to Brazil early in December to superintend the installation of a municipal and private plant in the city of Para. This is to be a plant of 1,000-h. p., and 10,000 lights capacity, with Corliss engines, compound condensing, and the highest grade dynamos for the alternating current system. A very large order for supplies has been placed in this city.

MR. G. H. ALMON, New York manager for the Belknap Motor Company, of Portland, Me., formerly with the General Electric Company, has been awarded the contract for installing a 500-light plant, 50-h. p. Armington & Sims engine, for the State Asylum for the Insane, at Waterbury, Vt. There was a large number of competitors, and Mr. Almon is justly pleased in getting the order. He will begin on the work at once.

THE OZONE MANUFACTURING COMPANY, of New York City, has been purchased by Dr. J. C. Dittrich, the late chemist of the concern. The plant and factory are situated at the corner of North Eleventh and Berry streets, Brooklyn, E. D. Manufacturing will be resumed at once, and Dr. Dittrich will then be prepared to furnish ozone preparations and machines for deodorizing, etc., of the best known description.

R. T. M'DONALD, of the Fort Wayne company, was indicted on Monday, November 27, on a number of counts on certain charges growing out of the failure of the Madison Square Bank. From the newspaper accounts Mr. McDonald appeared to have been the only one of the directors who attempted to stem the tide of mismanagement, and his friends think that the indictments are based upon technicalities rather than upon any grounds derogatory to his character.

MR. CHARLES C. BLIZARD, formerly secretary of the Franklin Electric Company, 136 Liberty street, New York, has resigned his position as such, and will hereafter be connected with the Electric Storage Battery Company, of Philadelphia. This company is the sole American manufacturer of the chloride accumulator, and Mr. Blizard's long experience in this branch of the electrical profession should prove of benefit both to the company and himself.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Nov. 25, 1893.

THE AMERICAN ELECTRIC COMPANY, the manufacturer of the New Era electric gas lighter, has moved to its new factory, located at 102 Pearl street.

THE PENNOCK BATTERY FRAUD has opened offices at No. 22 Exchange Place, Boston, Mass. Pennock, it will be remembered, visited this city once before, but did not find it a very profitable field to work.

NATIONAL INDIA RUBBER COMPANY, BRISTOL, R. I.—The main gear which operates the mixing and washing mills of the above company broke recently, necessitating the shutting down of all departments of the works, which have just again been started.

THE SWAIN TURBINE MANUFACTURING COMPANY, of Lowell, has recently equipped the works of B. B. & R. Knight, at Mauchany, with a 30-inch and 36-inch wheel, respectively. This makes the total number of new Swain turbine wheels in use at the various mills of this firm 25.

THE STATE STREET HORSE RAILWAY COMPANY, at New Haven, Conn., has placed the contract for the roof of its new power house with the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be 84 feet wide and 250 feet long, the roof trusses being of iron, covered with slate.

MR. F. A. SWAN, of Boston, Mass., is at present wiring the office of the Ludlow Manufacturing Company, this city, using the system of the Interior Conduit. He has also secured the contract to wire the addition to Mr. Frank Lock's cafe. We are informed that all the electrical displays in the present cafe were constructed by Mr. Swan. Besides these, Mr. Swan has his men at work at the National Tube Works, at East Boston. The work at the Bijou Theatre is nearing completion. This will be one of the handsomest plants in this city, over 40,000 feet of brass armored conduit being used in connection with the plant.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
926 MONADNOCK BUILDING, CHICAGO, Nov. 25, 1893.

THE CHICAGO INSULATED WIRE COMPANY has established offices at 207 South Canal street.

MR. A. C. FLETCHER, so long identified with the electrical interests of Cleveland, will hereafter conduct a newspaper advertising business under the name of Fletcher Newspaper Advertising Agency.

THE ELECTRIC APPLIANCE COMPANY reports that its trade is generally very highly pleased with the Packard lamp as it is now being made. The Appliance company is in receipt of unsolicited testimonials from a number of customers, which are certainly very complimentary to the lamp, and which indicate that it continues to hold its place as the Packard high grade lamp, with the emphasis on high grade. The "Mogul," "High Candle Power" and "Baby" Packards are also in large demand.

THE METROPOLITAN ELECTRIC COMPANY announces its incorporation, with offices at 522 Monadnock Block, salesroom at 307 Dearborn street, and factory at 171 South Canal street. The officers of the company are: Wm. H. McKinlock, president; W. C. McKinlock, secretary. The company has absorbed the Enterprise Electric Company, which did a general supply business. The Metropolitan Electric Company, together with this business, will have the supervision of a factory and and of its entire output, products of which will consist of H. T. Paiste's electrical specialties, comprising switches, sockets, porcelain rosettes, branch blocks, main line blocks, and general apparatus of this character. They have retained the general western agency of the N. I. R. wires and cables, and have also made arrangements with other well known manufacturers to handle their specialties, and will carry a large stock of staple goods.

News of the Week.

ELECTRIC LIGHT AND POWER.

EDINBURG, IND., proposes to have the electric light.

BLISSFIELD, MICH., is discussing the subject of electric lighting.

VILLISCA, IA., voted 243 to 36 in favor of granting an electric light franchise.

MINNEAPOLIS, MINN., is having plans prepared for a municipal lighting plant.

WELLINGTON, KAN., is being canvassed with a view of introducing the electric light.

BANGOR, ME., has contracted for arc lights at the rate of $60.50 per annum and $15 for incandescents.

BROOKLYN, N. Y.—It has been decided to use electricity for operating the draw on the Vernon avenue bridge.

CARMI, ILL., has granted an electric lighting franchise, and agreed to use 30 all-night arcs at $90 per annum apiece.

AMERICUS, GA.—An electric generator, to supply 20 incandescent lamps and a gas machine, will be bought by the "Times-Recorder."

HERMITAGE, WYOMING CO., N. Y.—Residents propose to utilize the water power long known as Blodgett's Pond, and they will at once establish an electric light plant.

PORTSMOUTH, N. H.—Constructor John B. Hoover has recommended a number of improvements for the Navy Yard, including an electric lighting plant, to cost about $6,432.

PHILADELPHIA, PA.—Johnston & Byrens, of 1217 Filbert street, have taken out a permit as contractors for the addition to the dynamo house and plant for Girard College.

CATAWISSA, PA.—Judge Shuman is booming a scheme for establishing a water-works and electric light company at Catawissa.

WOBURN, MASS.—Both the aldermen and Common Council have passed for the second time a resolution favoring municipal lighting.

PATERSON, N. J.—Work on the central station for the Edison Illuminating Company, at Van Houten and Prospect streets, is to be begun at once.

NUNDA, N. Y., pays $1,350 per year for 27 arc lights, and Palmyra, N. Y., has contracted for 30 arc lights and six incandescents for $2,000 per year.

WILKESBARRE, PA.—The Public Property Committee has been authorized to make contracts for electric wires and speaking tubes for the new city building.

CLEVELAND, O.—An electric plant will likely be a feature in the equipment of the building being erected by the Permanent Building and Loan Association. S. R. Badgley is architect.

TUCSON, ARIZ.—The electric light plant will be enlarged Dec. 1. At a recent session of stockholders it was decided to purchase two more dynamos of a capacity of 750 lights each.

ALLEGHENY CITY, PA.—J. J. Bothwell brought up in Common Council, of Allegheny, the matter of a new electric light plant, and the question was referred to the Committee on Public Works.

SPRINGFIELD, MO.—At meeting of the Council, Mr. Noe, the clerk, was authorized to correspond with various electric lighting men about making plans and specifications for an electric lighting plant for Springfield.

LONDON, ONT.—Sealed proposals will be received to Nov. 30 for an electric arc light plant for the city of London, including boilers, engines, etc., as per specifications at the office of the city engineer, A. Ormsby Graydon.

FARGO, N. DAK.—Bids are asked to Dec. 6 for an electric light plant for the county court house, including a 10½-h. p. gasoline engine and a 110-incandescent light dynamo; also for wiring the building. C. H. Anheier, County Auditor.

CAMBRIDGE, MASS.—The Joint Committee of Cambridge, appointed to consider the matter of a municipal street lighting plant, reported in favor of the purchase of the present gas plant from the owners and the operation of same by the city.

EAST HARTFORD, CONN.—The residents of East Hartford have voted, by a large majority, against the proposed electric light system. The residents of the centre district were in favor but residents of the outer sections were strongly opposed. The demand for improved street lighting is very strong.

AMBLER, PA.—It has been decided, at a meeting of citizens, to vote at a special election in the matter of issuing bonds to the amount of $15,000 to pay for an electric lighting plant. At present the town is in total darkness by reason of the lapse in the five-year contract for lighting made with the Ambler Electric Light Company.

NORTH ATTLEBORO, MASS.—The committee appointed to expend the $50,000 appropriated for the municipal electric lighting plant have had submitted to them the detailed drawings and plans of Mr. Mailloux, of New York, the consulting engineer, and from now on the work will go on as rapidly as materials and machinery can be procured.

THE ELECTRIC RAILWAY

NORTHAMPTON, MASS.—The Northampton Electric Railway Company has begun survey for its proposed extension to Williamsburg, eight miles.

NORTH ABINGTON, MASS.—At a meeting of the Rockland & Abington electric road, at their offices on North avenue, in North Abington, it was decided to extend the road to a point near Assinippi and Hanover.

PITTSBURGH, PA.—The Council, by a vote of 19 to 14, voted to reconsider the ordinance of the Pittsburgh & Mansfield Rail-

way Company, and this brings the ordinance to third reading, and it can be brought up at any time.

TERRE HAUTE, IND.—The Electric Street Railway Company contemplates extensive improvements, such as rebuilding cars, heating cars, repairing wires and replacing the old motors with a complete new set. Russell B. Harrison is president.

RANDALLSTOWN, MD.—The members of the Randallstown & Baltimore Rapid Transit Association met in the Randallstown Hall. E. S. W. Choate presided and R. B. Chapman was secretary. A committee was appointed to confer with some prominent engineer as to probable cost of route.

HAMILTON, ONT., CANADA.—The proposed inclined railway on Wentworth street is likely to become an assured fact. J. W. Lake has gone to New York to get estimates on cost of machinery and plant, and he will return and report on same before definite steps are taken.

BROOKLYN, N. Y.—The South Brooklyn Terminal Company has obtained permission to extend its tracks through New Utrecht and Flatbush to Jamaica, L. I., but the company has been directed to lay its tracks below the grade whenever the line crosses a public highway.

NIAGARA FALLS, N. Y.—It is stated that the Dominion Parliament will be petitioned by the Niagara Falls and Suspension Bridge companies for the privilege to lay tracks on their present structure for the purpose of running cars by cable, electricity or horse power, and also for leave to construct an auxiliary bridge for that purpose.

CLEVELAND, O.—There is a revival of the rumor that an electric railway will be built between New York and Chicago, and a special to the New York papers of the 22d inst. contained the statement that a meeting was being held at the residence of Dr. J. C. Anderson, of 1019 Euclid avenue, Cleveland, O. No details have been published.

WHITESTONE, L. I., N. Y.—It is proposed to build the Whitestone & College Point Railway from the government station at Willett's Point to Whitestone, thence to College Point. For the present the road will likely be single tracked, and the storage battery system is to be used. It is stated that the New York & College Point Ferry Company is interested.

WHITE PLAINS, N. Y.—The Board of Trustees meet this 21st November to act on an application for the granting of a franchise to the New York, White Plains & Mamaroneck Railroad Company, and the New York, Elmsford & White Plains Railroad to construct and operate a single or double track railroad to be operated by electricity between the points mentioned.

CAMDEN, N. J.—The West Jersey Traction Company and the Camden Horse Railroad have been seeking the privilege of crossing the State street bridge over Cooper Creek for the purpose of making connections in Stocktown township, and by six to three the Camden Board of Freeholders granted permission to the Camden Horse Railroad. This shuts out the West Jersey Traction Company.

BURLINGTON, VT.—Since the street railway company refused to take up at present the matter of extending their system to Fort Ethan Allen some of the gentlemen interested in the military post have organized and propose to build this road and take power from the station of the Vermont Electric Power Company at the Gorge. Gen. T. S. Peck and Edward Wells are leaders in the movement.

WILKESBARRE, PA.—The Wilkesbarre & Plymouth Street Railway Company has applied for right to lay tracks and operate a street railway, and the ordinance has passed first reading and been referred to the Law and Ordinance Committee and the City Attorney. They propose to operate by electricity. The Wilkesbarre & East Side Electric Railway was also granted right of way over the principal streets in the heights.

SHENANDOAH, PA.—The Lakeside Electric Railway will build a power house, 75 by 125, in Mahanoy City. The Seely Manufacturing Company, of New York, has the contract for overhead electrical work. C. E. Tillman has contract for poles and sills, and the Pottsville Spike and Bolt Company have the contract for the spikes and bolts. The road will be in operation by Jan. 1, 1894. The Westinghouse company has already completed the electrical apparatus for the cars.

BALTIMORE, MD.—The West Baltimore Passenger Railway Company is before the County Commissioners of Baltimore County with a petition for leave to build and operate an electric road through the Thirteenth District, from Baltimore to the Relay House, Baltimore & Ohio Railroad. The company is represented by its president, Mr. Wallace Stebbins. The projectors of the Baltimore & Washington Boulevard were also present, represented by Howard Munnikhuyson, and he states that his company also proposes to build an electric railway. On request of Mr. Munnikhuyson the matter will be laid over for 60 days.

FALLS CHURCH, VA.—At a meeting held in Odd Fellows Hall the sum of $11,000 was subscribed toward the proposed electric road. It is proposed to expend $40,000 altogether on the road, which will form a loop in Falls Church, then run to Ballston, Va., and then to a point near the aqueduct bridge, with a branch to Fort Myer and Arlington. Major Hines, of Vienna, Va., has also interested himself. The only objection urged at the meeting was the fact that the road would end at the Virginia end of the aqueduct bridge, and that passengers would, therefore, have to be transferred to the capital in herdics.

MISCELLANEOUS NOTES.

A YOUTHFUL ELECTRICIAN.—The city electrician of Bloomfield, N. J., is a youth of 15 years.

MR. D. M'FARLAN MOORE will lecture before the Brooklyn Institute, Friday, Dec. 1, on Decorative Electricity.

JEFFERSON, IA., expects soon to have the electric light. Citizens interested are D. Milligan, S. C. Lee and F. M. Riley.

MR. A. B. DAVIS, general manager of the Viaduct Manufacturing Company, Baltimore, met with a sad affliction in the loss of his wife, who died, after a lingering illness, on Nov. 18.

AND THIS IS FAME!—The New York "World," of Nov. 20, in a paragraph referring to the electrocution of McElvaine, says: "Nicola Tesla, who was first sentenced to die at the same time, had his sentence commuted to life imprisonment.

FRANKLIN INSTITUTE.—Papers will be read in the electrical section of the Franklin Institute on Nov. 28 by Egbert S. Cary on "A New Form of Quadrant Electrometer Needle for Power Measurements," and by Mr. E. G. Willyoung, on "Resistance Standards."

LICENSING WIREMEN.—The New York Board of Fire Underwriters has passed a resolution asking Governor Flower to recommend the passage of a law requiring persons desiring to do electric light wiring to pass an examination and to get a license, just as engineers have to.

THE FRANKLIN INSTITUTE OF PHILADELPHIA announces a course of lectures on theoretical and applied electricity. The following are the names of the lecturers and the subjects: Prof. Elihu Thomson, "Thoughts on Cosmical Electricity," Dec. 19; Prof. H. S. Carhart, "The Theory and Design of the Closed Coil Constant Current Arc Dynamos," Dec. 26; Mr. J. J. Carty, "Telephony," Feb. 27, 1894; Prof. M. I. Pupin, "Magnetic and Dielectric Viscosity," April 24, 1894; Dr. Wm. J Morton, June 26, 1894, on a subject not yet announced.

"ELECTRICITY AT THE WORLD'S FAIR" was the subject of an interesting lecture delivered before the Buffalo Electrical Society at its last meeting, Nov. 16, by the society's president, Mr. Philip K. Stern. The attendance was large and there promises to be a revival of interest among local electricians this winter. President Stern, Frank Kitton and Frank C. Perkins were appointed a committee to secure, if possible, for the next meeting Prof. George Forbes. The society has written to Mr. Nikola Tesla with a view to making arrangements for a lecture in the near future.

THE NATIONAL BROTHERHOOD OF ELECTRICAL WORKERS has elected the following officers: Grand president, Quirn Jansen, of Milwaukee; grand secretary and treasurer, J. T. Kelly, of St. Louis; first grand vice-president, N. Duff, of Cleveland; second grand vice-president, H. W. Sherman, of Rochester, N. Y.; third grand vice-president and grand organizer, Henry Miller, of St. Louis; executive board, J. W. Fitzpatrick, of Philadelphia; J. J. Vaves, of New Orleans; F. J. Roth, of Kansas City; William Prickett, of Wheeling, W. Va., and the former grand officers.

THE NEW YORK ELECTRICAL SOCIETY will hold a symposium at Columbia College, Forty-ninth street and Madison avenue, at 8 p. m. on Nov. 29. The subject of the evening will be: "Electricity at the World's Fair and Its Lessons." Brief addresses will be given by J. J. Carty, on Telephones; Prof. F. B. Crocker, on Electrical Congresses; Charles Cuttriss, on Cables; Dr. C. E. Emery, on Electric Light Engines; James Hamblet, on Electric Clocks; C. O. Mailloux, on Storage Batteries; T. C. Martin, on Electric Lighting; Nikola Tesla, on his new Electrical Oscillator; Jos. Wetzler, on Transportation, and Schuyler S. Wheeler, on Electric Motors. A large number of lantern views of the World's Fair will be thrown on the screen. Ladies will be welcome at this meeting.

Trade and Industrial Notes.

THE MARIETTA, O., Manufacturing Company will manufacture arc light carbons.

THE THOMSON ELECTRIC WELDING COMPANY has removed its offices from Boston to Lynn, Mass., where all correspondence should hereafter be sent.

THE HAWKE ELECTRIC COMPANY, of Boston, has the contract for most of the outside work in connection with the new electric light plant for North Attleboro, Mass.

THE CALDWELL WATER TUBE BOILER is now being manufactured for the Western territory by the Link-Belt Machinery Company, of Chicago, Ill., with sales agencies in the principal cities.

THE ZUCKER & LEVETT CHEMICAL COMPANY, 10 Grand street, New York, informs us that they received the highest and only award of the World's Fair for electroplaters' supplies and polishing material.

THE DALLAS (TEX.) ELECTRIC CONSTRUCTION COMPANY, W. A. Frazer, general manager, is the only house in Northern Texas that deals exclusively with electrical matters, and as a consequence is kept busy covering its wide territory.

THE CINCINNATI MILLING MACHINE COMPANY have issued a well printed and illustrated catalogue of their new universal tool grinder. A noteworthy feature consists of over 25 well drawn outline cuts, showing the operation of the machine applied to different uses.

THE METROPOLITAN ELECTRIC COMPANY, Chicago, reports the receipt of a very important order for N. I. R. wire. This wire is coming into favor very rapidly, contractors and builders finding that it meets every requirement. The Metropolitan carries a large stock of all sizes, and is enabled to fill orders promptly.

MR. C. R. ARNOLD has purchased at public sale the machinery, tools, stock, good will and fixtures of the Arnold Electric Manufacturing Company, Chester, Pa., and is now engaged operating the factory, pending an organization under the title of the Arnold Electric Company, and in the meantime is prepared to fill orders.

THE ELECTRIC STORAGE BATTERY COMPANY, Drexel Building, Philadelphia, has issued a handsome catalogue describing and illustrating the chloride accumulator. The matter contained will be of value to all interested in accumulators and also to electrical students on account of the thorough manner in which the subject is treated.

MESSRS. QUEEN & COMPANY, Philadelphia, report the week ending Nov. 25 "the red letter week of their existence." More and larger orders were received and executed during last week than had ever been received before during the same length of time. Among the largest orders received were from Armour Institute, Chicago; Chicago University, Chicago; and the Western University of Pennsylvania, Pittsburgh, Pa.

MR. S. NORRIS CRAVEN, who, in conjunction with Mr. E. A. Blanton, leased the Howard Foundry and Machine Company, 17 South Eighteenth street, Philadelphia, has severed his connection with the above, and has leased the three-story building, 515 Mulberry street, where, having installed new and improved machinery, he will, under the firm name of S. Norris Craven & Company, Limited, manufacture electric, hydraulic, belt and hand power elevators.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has placed on the market, under the name of the Standard single push, an improvement on the flush push switches now made in that it is operated by only a single button, instead of one button to throw on the light and one button to throw it off. The first push throws on the light and the second push on the same button throws it off, or vice versa. The switch is thus enabled to be made more compact and neater in appearance, and is lower in price than the double button push switches.

THE WOOD WATER TUBE SAFETY BOILER, whose main works are at Conshohocken, Pa., is also manufactured at Saginaw, Mich.; St. Louis, Mo., and Zanesville, O., and works will soon be started at Boston, Mass., and San Francisco, Cal. Some of the smoke pipes furnished with some recent boilers are said to be the largest built in this country, being eight to ten feet in diameter and 175 feet high. Among a large number of orders recently received is one for 1,000 h. p. for the Calumet & Hecla Street Railway Company, of Chicago, and another for 400 h. p. for the Bay City Electric Light Company, Bay City, Mich.

W. R. FLEMING & CO., New York and Boston representative of the Harrisburg Foundry and Machine Works, report the following sales for this month: Two 60-h. p. Ideal engines for the Hanover Fire Insurance Company, New York; two 100-h. p. Ideal engines for the American Express Company, New York; two 175-h. p. Ideal engines to the State Asylum for the Insane, Norristown, Pa. (all the above are to be direct connected to dynamos); one 40-h. p. standard Ideal engine to J. & J. Rogers Co., Ausable Forks, N. Y.; two 60-h. p. standard Ideal engines for the Brazilian warship "Nictheroy"; one 40-h.p. Ideal engine, Brooklyn Street Railway Company, Brooklyn, N. Y.; two 50-h. p. engines for the General Electric Company, New York; 160-h. p. Harrisburg high-pressure boiler plant for the H. W. Johns Company, South Brooklyn, N. Y., and one 150-h. p. high-pressure boiler plant for the New York & Pennsylvania Company. Messrs. Fleming & Co. report that most of the work in their shops at present is for direct connected engines. They are building the latest and most improved apparatus for this work.

THE CENTRAL ELECTRIC COMPANY, of Chicago, who are the exclusive general Western agents, as illustrating the increasing demand and the popularity of the Interior Conduit and Insulation Company's system of interior conduits, state that the great buildings of the city that have been constructed in the past season, almost without exception, have been equipped with the Conduit company's tubing, the list including the Title and Trust Building, 100 Washington street, 3,000 lights; La Kota Hotel, Thirtieth street and Michigan avenue, 3,000 lights; Illinois Central Railway Depot, 4,300 incandescents and 74 arc lamps; Teutonic Building, Fifth avenue and Washington streets, 1,900 lights; A. W. Sullivan's residence; Dr. Frank S. Johnson's residence, 2,542 Prairie avenue; Chicago Athletic Building, 3,100 lights; Columbus Memorial Building, 4,000 lights; New Era Building, 1,790 lights; New York Life Building, 2,800 lights; Windermere Hotel, 3,000 lights; W. A. Dunchee's large apartment building, 1,000 lights; Congress Hotel, 7,300 lights. Among the buildings now under process of construction, the specifications of which call for interior conduit, are the Chicago Stock Exchange Building, 5,500 lights; Marquette Building, 4,000 lights.

THE MIAMISBURG ELECTRIC COMPANY, of Miamisburg, O., whose Milwaukee convention exhibit was noticed in these columns, are now in the market supplying the "Burnley Cartridge Battery," "the Imperial Dry Battery" and tempered copper. Mr. Burnley, who has had an extensive experience in the manufacture of batteries, is in charge of their battery department. His present type of cell is something new in sal ammoniac batteries. The cell used is made of specially prepared paper, rendering it non-breakable and much lighter than other types. Its weight is claimed to be but one-third that of any other cell of the same capacity, while its E. M. F., being 1.47 volts, is somewhat higher. Great durability is obtained because of rapid depolarization. The new type of "Imperial" dry battery embodies all the latest improvements. These include an entire absence of the danger of internal short-circuiting and the consequent loss of energy arising therefrom, thus maintaining its initial force over long periods of time, and enabling the manufacturers to sell an article that can be absolutely guaranteed. It is so constructed that it will withstand short-circuiting without injurious loss of initial force. The company have recently placed on the market a medical battery equipped with "Imperial" cells that is meeting with much favor. Owing to the fact that their tempered copper had not been thoroughly tested and standardized in time, no exhibit of this branch of their industry was made at the World's Fair. It is now in good shape, however, and has been adopted by many manufacturers. It is claimed for this copper that it has density, conductivity and good wearing qualities. It is made from pure Lake copper and is entirely free from alloys.

THE STIRLING COMPANY sends us a communication referring to the announcement of the Babcock & Wilcox Boiler Co. that appeared in these columns in the issue of Nov. 11. It states that the Babcock & Wilcox Co. seemed to labor under a misapprehension of the conditions under which the award was to be rendered, as the jury, not content with simply reviewing the claims of the Stirling company, detailed one of their number to investigate its boiler in actual operation at as many different points as could be reached. "The batteries at the World's Fair were not alone subjected to the severest scrutiny and examination, but a number of plants operating in Chicago were visited, as well as in Circleville, O.; Pittsburgh, Pa., and also Allentown, Pa., at which latter place a Babcock & Wilcox battery was operating alongside of ours, and a comparison was made between the two." It is well known, the Stirling company says, that efforts were made by the Jury of Awards to have tests made on as many boilers in the boiler room as possible, and to that end they addressed a circular letter to the exhibitors proposing that each one should bear the expense of having a test made on his plant. "None of the other six companies exhibiting in the main boiler room would agree to submit to this charge except ourselves. We not only sought a test, but addressed a letter to the Jury of Awards, in which we challenged each competitor in the main boiler room to a test, but we wanted a competitive test or none at all, objecting to having the results of a test conducted scientifically by such men as were proposed to make it compared with the 'dress parade' tests published by other companies." The communication further says that the attitude of the Babcock & Wilcox cannot be considered altogether consistent when it is borne in mind that their representative on the witness stand stated that their boilers had not and would not be entered as an exhibit, and as concerns the allegation of the Babcock & Wilcox representative that one of the reasons which induced them to make so vigorous a fight against the Stirling boiler being installed alongside of theirs was because he considered it unsafe, the following challenge is issued: "If the Babcock & Wilcox Company, or any one else, can point to a single instance in which the Stirling boiler exploded, resulting either in loss of life or injury to man or beast, we will pay twenty-five hundred dollars ($2,500) to any charity in the city of Chicago that they may designate."

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N.Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

UNITED STATES PATENTS ISSUED NOV. 21, 1893.

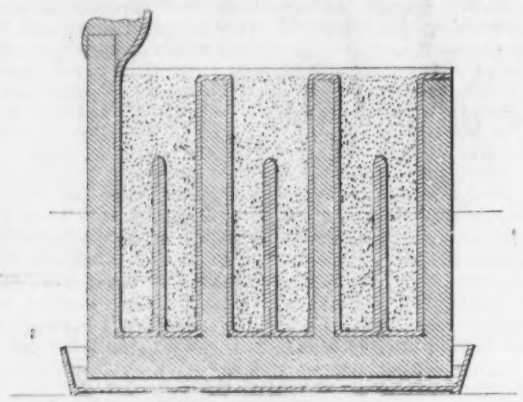
(IN CHARGE OF W. A. ROSENBAUM, 177 TIMES BLDG., N.Y.)

508,926. CASING FOR ELECTRIC ARC LAMPS; P. Federmann, Berlin, Germany. Application filed Feb. 23, 1893. In an arc lamp casing the combination with an upper fixed part and a lower sliding part, of an intermediate part provided with an insulating disc into which the lamp is removably fitted.

508,946. AUTOMATIC RAILWAY ELECTRIC SIGNAL; B. A. Karr and C. H. Bradrick, Omaha, Neb. Application filed Dec. 27, 1892. This consists of a main track and a central track and trolley running thereon, the trolley adapted to operate an alarm device carried by the engine.

509,002. ELECTRIC RAILWAY; J. H. Vail, New York, N. Y. Application filed March 17, 1893. This comprises an electric railway having two working conductors, each connected with a number of separate conductors extending from one terminal of the source and having a predetermined fall of potential.

509,014. ELECTRIC ARC LAMP; H. P. Ball, Brooklyn, N. Y. Application filed March 2, 1891. An arc lamp with clutch feed, a shunt magnet having a tapering armature or pole piece, or both, a cut-out operated by the armature, and a cut-out coil acting on the armature.



NO. 509,267.—STORAGE BATTERY.

509,036. AUTOMATIC THERMAL CUT-OUT FOR INCANDESCENT ELECTRIC LAMPS; E. H. Johnson, New York, N. Y. Application filed April 13, 1886. An incandescent lamp having the leading-in wires bridged by a substance which is normally an insulator, but which, when the circuit is broken in the lamp, will be melted or volatilized to form connection between the leading-in wires.

509,050. ELECTRIC BELL; W. J. Schweiger, New York, N. Y. Application filed March 15, 1893. An electric bell having the hammer attached to the armature of the magnet and vibrating in a notch in the dome.

509,056. THERMOSTAT; H. S. Tunnard, Rugby, and A. M. Keays, Sutton, England. Application filed March 27, 1893. A mercurial thermostat consisting of a bore of two sizes and provided with slotted adjustable slides and binding screws therefor.

509,061. SPEAKING ATTACHMENT FOR TELEPHONES; W. and G. Weber, Philadelphia, Pa. Application filed Sept. 16, 1893. This comprises a speaking tube having one end secured to the transmitter of a telephone and the other rigidly attached to the receiving phone, so that when the phone is held to the ear the mouthpiece of the tube will be in front of the speaker.

509,065. ELECTRIC RAILWAY CONDUIT; G. T. Woods, New York, N. Y. Application filed Sept. 25, 1893. An electric railway having a series or closed boxes arranged in the conduit, the boxes having interior contact devices and laterally projecting switch arms, and a brush carried by the car and having a contact face, against which the switch arms work.

509,066. TELEGRAPHY; J. P. Wooten, Bainbridge, Ga. Application filed Nov. 13, 1892. This comprises a number of relays connected in series and having their armatures adjusted to offer differing mechanical resistances, and a ground connection and circuit maker and breaker for each armature.

509,072. ELECTRIC RAILWAY; J. H. Dale, New York, N. Y. Application filed March 1, 1893. The combination of a closed box and contact devices and shaft contained therein and a switch arm projecting laterally from the shaft and having a contact head capable of yielding radially with reference to the shaft, and rocking axially.

509,085. ELECTRIC CIGAR LIGHTER; C. J. Jenne and C. E. Willey, Louisville, Ky. Application filed April 5, 1893. This consists of a primary and secondary circuit and a lamp in the secondary circuit. A switch in the primary circuit is normally closed to the lamp, but when the lamp is lifted the switch is opened and the lamp is lighted.

509,091. MAGAZINE GUN AND ELECTRICAL DEVICES THEREFOR; J. L. McCullough, Brooklyn, N. Y. Application filed Dec. 12, 1892. The combination with the barrel, the casing, and chambered carrier mounted therein and having in each of its chambers a sliding, permanent shell, a lever provided with a hook to engage the shells and a stud and an operating slide provided with means for actuating and holding the lever.

509,093. ELECTRO MECHANICAL SLOT MECHANISM FOR RAILWAY SIGNALS; T. H. Patentall, Rahway, N. J. Application filed Jan. 6, 1893. The combination with a signal and mechanical means for operating it, of an auxiliary device for operating the signal, an electromagnet and a system of compound levers, including two separable, interlocking angle levers, connecting the armature of the magnet to the auxiliary signal operating device for operating the signal by electricity.

509,095. ELECTRIC METER; John Perry, London, England. Application filed March 28, 1893. A rotary shaft carrying at one end an armature entirely immersed in mercury, and at the other end making contact through mercury, in combination with an electric circuit, the terminals of which are respectively in the bodies of mercury. (See illustration.)

509,116. ELECTRICALLY CONTROLLED DOOR; F. Callahan, Bridgeport, Conn. Application filed April 8, 1892. The combination with springs normally adapted to open the door, of a catch plate carried by the door, a pivoted hook to engage the catch, an armature carried by the hook, and an electromagnet supported contiguous to the armature.

509,123. TROLLEY MECHANISM; J. T. Fuller, Calvert, Tex. Application filed July 17, 1893. The combination with a trolley pole stud, of a wheel carrying yoke pivotally mounted thereon, the stud having a socket in the yoke adapted to receive a lubricating plug.

509,127. BLOCK SIGNAL APPARATUS; A. H. Johnson and T. H. Patenall, Rahway, N. J. Application filed March 20, 1892. In combination, a vibrating lever, a locking device for holding it in position, a tappet, a swinging sector forming a connection between the locking device and tappet, a stop for locking the tappet and a movable connection between the stop and the tappet.

509,167. ELECTRIC ARC LAMP; R. M. Hunter, Philadelphia, Pa. Application filed June 29, 1893. An electric lamp post consisting of a vertical pole, having at its top a tubular portion, combined with an electric regulator for the lamp proper, located within the tubular portion and shielded thereby, the lamp proper being supported by an arm of the post.

509,168. ELECTRIC ARC LAMP; R. M. Hunter, Philadelphia, Pa. Application filed June 29, 1893. A lamp consisting of a frame with two carbon-feeding rods provided with feeding devices for each of the rods, and a vertical moving part adapted to operate both of the feeding devices and extending upward through the top of the frame or case in an exposed position. (See illustration.)

509,171. ELECTRIC SIGNAL RECEIVER; W. H. Kirnan, Bayonne, N. J. Application filed April 17, 1893. The combination of a magnet in the signaling circuit, a magnet in a clock controlled circuit and a disabling device for the time indicating mechanism affected alternately by said magnets and moved thereby respectively in and out of its disabling position.

509,181. COIN CONTROLLED RENTING MACHINE; G. Richmond, New York, N. Y. Application filed July 10, 1893. In a renting machine the combination of a clock motion, a shaft driven thereby, a coin carrier loose upon the shaft, a plate and ratchet attached to the shaft, a ratchet attached to the coin carrier, a pawl attached to the plate and adapted to engage the ratchet, and a button containing a pawl adapted to operate on the ratchet.

509,186. TELEPHONE EXCHANGE APPARATUS; C. E. Scribner, Chicago, Ill. Application filed Feb. 21, 1893. The combination with a telephone circuit provided with means for sending calling currents either constant or alternating in direction, of an annunciator connected in a bridge between the different sides of the circuit, the annunciator being arranged to be irresponsive to alternating currents by encircling a portion of the magnetic circuit of its electromagnet by an auxiliary closed conducting circuit.

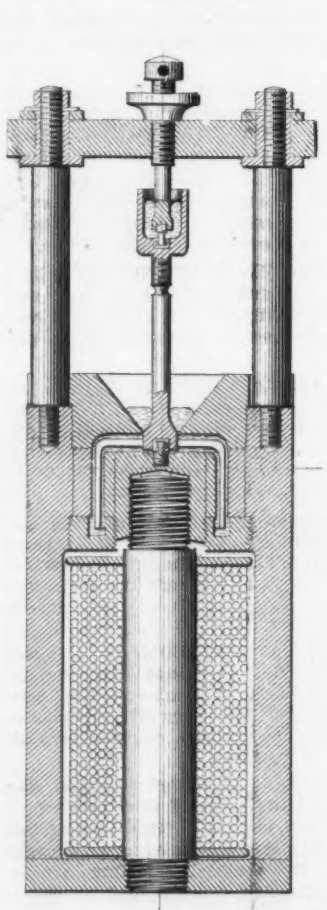
509,188. ELECTRIC ARC LAMP; B. B. Ward. Application filed Feb. 15, 1893. This consists of a derived circuit feed magnet coil, an artificial protecting resistance operating as an assisting coil in starting the lamp but normally out of circuit with the coil, and means for throwing the resistance coil into the circuit when the arc becomes abnormally long or the lamp goes out of action.

509,201. RAILWAY TRAIN ORDER AND SIGNALING DEVICE; L. T. Crabtree, New London, Wis. Application filed June 24, 1893. The combination with a supported electromagnet, an armature bar pivoted at its lower end, a battery, and means to make and break a circuit between the battery and the magnet, a top-heavy gravity block pivoted at its lower end, a pendantly supported and rotatable signal blade and a device connecting the signal blade support with the gravity block.

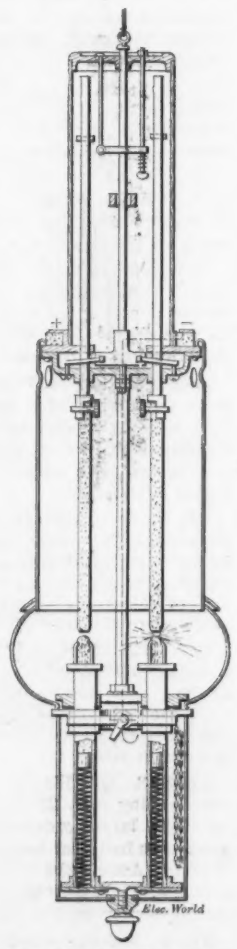
509,216. FIRE ALARM TELEGRAPH REPEATER; T. F. Gaynor, Louisville, Ky. Application filed March 2, 1891. The combination of a circuit changer, a circuit closer carrier, motor mechanisms for the same, a cam connected with one of the mechanisms, and a lever co-operating with the cam and arranged thereby to control the other motor.

509,217. COMBINED ELECTRIC TIME STAMP AND SIGNAL DEVICE; T. F. Gaynor, Louisville, Ky. Application filed March 7, 1891. The combination with a circuit and an electromagnet therein, of a pivoted armature, a printing lever carried by the armature, type-carrying mechanism, a rotating detent engaging the armature, a wheel in the circuit carrying the detent, the wheel in its revolution opening and closing the circuit.

509,218. ELECTRIC SIGNAL DEVICE; T. F. Gaynor, Louisville, Ky. Application filed March 16, 1891. The combination of a signal circuit wheel, a shaft in gear therewith, motor mechanism therefor, a lever loose on the shaft, but adapted to rock the same through a discontinuously operative connection, and a detent engaging the lever at the end of its stroke.



NO. 509,095.—ELECTRIC METER.



NO. 509,168.—ELECTRIC ARC LAMP.

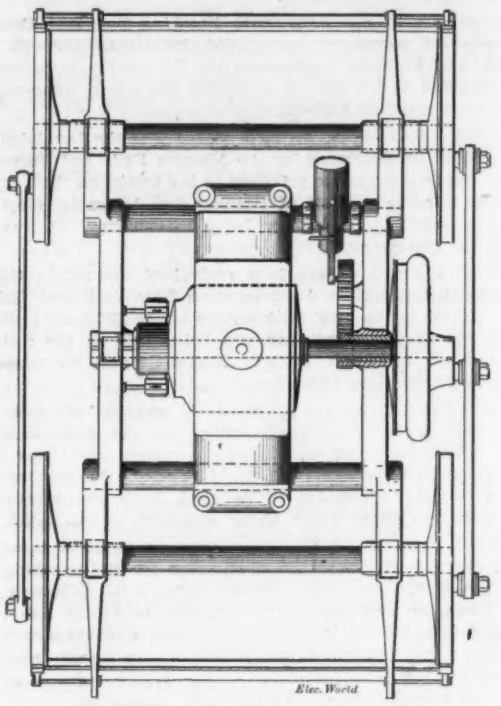
509,219. NON-INTERFERENCE SIGNAL BOX MECHANISM FOR FIRE ALARM TELEGRAPHS; T. F. Gaynor, Louisville, Ky. The combination with a door of a stud having a loose jointed connection therewith and a switch provided with circuit terminals, which is adapted to be moved by the stud whenever the door is closed.

509,244. ELECTRICAL APPARATUS FOR CONTROLLING SIGNAL OR OTHER CIRCUITS; H. A. Parrish, Jackson, Mich. Application filed Jan. 28, 1893. The combination with a signal bell, its local circuit and a magnet and pivoted drop, of a second magnet and armature for raising the drop and opening the signal circuit, and means for locking the drop [illegible] circuit is broken.

509,266. STORAGE BATTERY; E. P. Usher, Grafton, Mass. Application filed Jan. 23, 1893. In a storage battery, a series of suitable plates, each with a shouldered vertical stem or lug, in combination with a transverse bar connecting the several lugs and formed with a flat bottom and a series of vertical openings through it adapted to fit on the shouldered stem, such openings having side walls, increasing in obliquity from the bottom upward.

509,267. STORAGE BATTERY; E. P. Usher, Grafton, Mass. Application filed Jan. 23, 1893. A frame or skeleton having upright arms grooved along their inner edges, and a conducting ribbon or wire therein, formed with projecting tongues or loops in the plane of the plate, in combination with a filling of active material in a dry, powdered form, and with non-conducting separators inclosing such material laterally. (See illustration.)

509,268. STORAGE BATTERY; E. P. Usher, Grafton, Mass. Application filed Jan. 23, 1893. In a storage battery, a series of plates and interposed separators set in a shallow body of cement or gum, the several plates being supported at a slight distance above the bottom of the vessel containing the gum.



NO. 509,311.—ELECTRIC LOCOMOTIVE.

509,269. STORAGE BATTERY; E. P. Usher, Grafton, Mass. Application filed Jan. 23, 1893. A battery plate formed of a hollow shell of conducting metal perforated in its sides with outwardly projecting burrs at each perforation, and a filling of material to become active inclosed between such perforated walls.

509,270. STORAGE BATTERY; E. P. Usher, Grafton, Mass. Application filed Jan. 23, 1893. This consists of a cell divided into compartments by porous, non-conducting separators, in combination with electrodes in the compartments, each consisting of two sheets of conducting material perforated and vertically corrugated with a continuous layer of lead oxide, confined between the sheets, leaving the vertical spaces between such sheets and the adjacent separators clear and open.

509,271. STORAGE BATTERY; E. P. Usher, Grafton, Mass. Application filed Jan. 23, 1893. In a storage battery, lead plates, porous separators, end spacers to hold the parts in place, packed active material in the inclosed pieces between the parts, intermediate between their ends, and with a filling of material to become active, in the inclosed spaces.

509,272. STORAGE BATTERY; E. P. Usher, Grafton, Mass. Application filed Jan. 23, 1893. A battery cell comprising a suitable case subdivided by a porous separator, a body of material adapted to become active, and a metallic conductor inclosed in each of the compartments of the case, open vertical wells formed in the material, and linings for the walls of such wells.

509,279. REGULATING SWITCH FOR ELECTRIC ELEVATORS; H. A. Allen, Chicago, Ill. Application filed Feb. 20, 1892. The combination with a switchboard and pivotal switch finger, of a pair of levers yieldingly connected by a spring and one of which is firmly connected with the switch finger to move it, and a pivotal dog interposed between adjacent arms of the two levers and extending at one end, as a stop, into the path of the lever connected with the switch finger and toward its opposite end, as a cam into the path of the other lever.

509,290. SIGNAL TELEGRAPH; C. V. Boughton, Buffalo, N. Y. Application filed Nov. 26, 1892. In a signal telegraph a set of levers pivoted upon a common rod and the contacting plates with projections and pivoted to each lever by a link, and adjusted by leveling devices, the whole being operated by rods and keys.

509,297. SOCKET FOR ELECTRIC LAMPS; W. C. Bryant, Bridgeport, Conn. Application filed March 22, 1893. This socket has screw-threaded bases, the sockets having contacts and an insulating ring at the mouth of the socket beyond the contacts and threaded for the direct reception and holding of the threaded base of the lamp.

509,311. ELECTRIC LOCOMOTIVE; J. C. Henry, New York, N. Y. Application filed Dec. 15, 1893. In combination with a truck, longitudinal bars forming part of the truck frame, a motor and brush holders for the motor supported directly by the bars. (See illustration.)

509,312. SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; J. C. Henry, New York. Application filed Aug. 20, 1889. In electric railways, the combination of conductors carrying an alternate current, exposed working conductors, branch conductors, an inductorium and a circuit completing device, including the car wheels and axles, and actuated at intervals by current from the secondary coils of the inductorium.

509,322. CURRENT CONTROLLING DEVICE; W. H. Morgan, Alliance, O. Application filed July 22, 1891. The combination with a motor, a rheostat and a reversing switch of a shaft, a bell crank lever thereon, a rack bar carried by one arm of the bell crank for actuating the movable contact of the rheostat, and a socket arm connected to the reversing switch and adapted to be engaged with and disengaged from the other arm of the bell crank.

509,328. HANGER FOR TROLLEY WIRES; G. H. Ricke, Cincinnati, O. Application filed Aug. 7, 1893. This hanger consists of two plates connected at their top edge and terminating in jaws, in combination with bifurcated clamps for grasping the plates near their end portions.

509,342. AMPERE METER OR VOLTMETER; Carl Wilkens, Frankfort-on-the-Main, Germany. Application filed July 19, 1893. In ampere meters and voltmeters the arrangement of an eccentric ring or cylinder between two solenoids, so that at the turning of the iron cylinder its axis is moved parallel to the axes of the solenoids, whereby the effect of the current in the solenoids will tend to coincide the two axes, the object of the arrangement being to employ a closed iron ring or cylinder, reducing the visible influence of the remanent magnetism and to attain a large deflection of the pointer.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1836—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N.Y.